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Tech Notes

June 1989

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PENNSYLVANIA STATE
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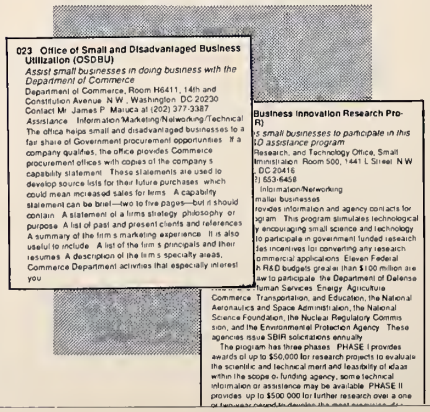
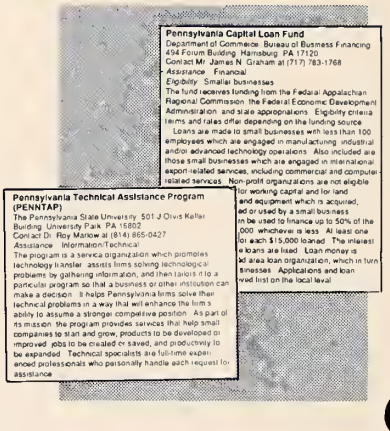
The 180 Federal entries selected for inclusion are arranged by agency. Discover sources of help in exporting, patent licensing, procurement, locating wage information, obtaining loan guarantees, finding marketing information, plus much more. A handy index lets you quickly locate just the Federal resources you need.


023 Office of Small and Disadvantaged Business Utilization (OSDBU)
Assist small businesses in doing business with the Department of Commerce
Department of Commerce, Room H6411, 14th and Constitution Avenue, N.W., Washington, DC 20230
Contact Mr. James P. Maruca at (202) 377-3387
Assistance: Information/Marketing/Networking/Technical
The office helps small and disadvantaged businesses to a fair share of Government procurement opportunities. If a company qualifies, the office provides Commerce procurement offices with copies of the company's capability statement. These statements are used to develop source lists for their future purchases which could mean increased sales for firms. A capability statement can be brief—two to five pages—but it should contain: A statement of a firms strategy, philosophy, or purpose. A list of past and present clients and references. A summary of the firm's marketing experience. It is also useful to include: A list of the firm's principals and their resumes. A description of the firm's specialty areas. Commerce Department activities that especially interest you

Business Innovation Research Pro-
R)
s small businesses to participate in this LO assistance program
Research, and Technology Office, Small ministration, Room 500, 1441 L Street, N.W. , DC 20416
) 653-6458
Information/Networking
maller businesses
rovides information and agency contacts for ogram. This program stimulates technological y encouraging small science and technology to participate in government funded research ies incentives for converting any research ommercial applications. Eleven Federal h R&D budgets greater than $100 million are aw to participate: the Department of Defense uman Services, Energy, Agriculture, Commerce, Transportation, and Education, the National Aeronautics and Space Administration, the National Science Foundation, the Nuclear Regulatory Commission, and the Environmental Protection Agency. These agencies issue SBIR solicitations annually.
The program has three phases. PHASE I provides awards of up to $50,000 for research projects to evaluate the scientific and technical merit and feasibility of ideas within the scope of a funding agency; some technical information or assistance may be available. PHASE II provides up to $500,000 for further research over a one or two-year period to develop the most promising ide


Pennsylvania Capital Loan Fund
Department of Commerce, Bureau of Business Financing, 454 Forum Building, Harrisburg, PA 17120
Contact Mr. James N. Graham at (717) 783-1768
Assistance: Financial
Eligibility: Small businesses
The fund receives funding from the Federal Appalachian Regional Commission, the Federal Economic Development Administration, and state appropriations. Eligibility criteria, terms, and rates differ depending on the funding source.
Loans are made to small businesses with less than 100 employees which are engaged in manufacturing, industrial and/or advanced technology operations. Also included are those small businesses which are engaged in international export-related services, including commercial and computer-related services. Non-profit organizations are not eligible
for working capital and for land
and equipment which is acquired,
ed or used by a small business
n be used to finance up to 50% of the
,000, whichever is less. At least one
lot each $15,000 loaned. The interest
e loans are fixed. Loan money is
ed area loan organization, which in turn
sinesses. Applications and loan
ved first on the local level.

Pennsylvania Technical Assistance Program (PENNTAP)
The Pennsylvania State University, 501 J. Orvis Keller Building, University Park, PA 16802
Contact Dr. Roy Marlowe at (814) 865-0427
Assistance: Information/Technical
The program is a service organization which promotes technology transfer, assists firms solving technological problems by gathering information, and then tailors it to a particular program so that a business or other institution can make a decision. It helps Pennsylvania firms solve their technical problems in a way that will enhance the firm's ability to assume a stronger competitive position. As part of its mission, the program provides services that help small companies to start and grow, products to be developed or improved, jobs to be created or saved, and productivity to be expanded. Technical specialists are full-time experienced professionals who personally handle each request for assistance.

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Tech Notes

Highlighting Selected U.S. Government Technology & Resources

June 1989

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Published monthly by the National Technical Information Service (NTIS), Tech Notes bring together individual one- to two-page fact sheets prepared by Federal agencies, their laboratories, or contractors. These fact sheets highlight current Federal technology determined to have commercial or practical application. Topics cover new processes, materials, techniques, software, instrumentation, and resources.

Some of the current sources are the Department of the Navy, Department of the Army, NASA, Department of Energy, Environmental Protection Agency, Department of the Interior, and the Department of Agriculture.

Special assistance is provided by the Federal Laboratory Consortium.

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How to Use Tech Notes

Every Tech Notes fact sheet lists a source for additional information. The source of this information may be a special support package from the originating agency, a personal contact, a licensing opportunity, or a backup report available from NTIS.

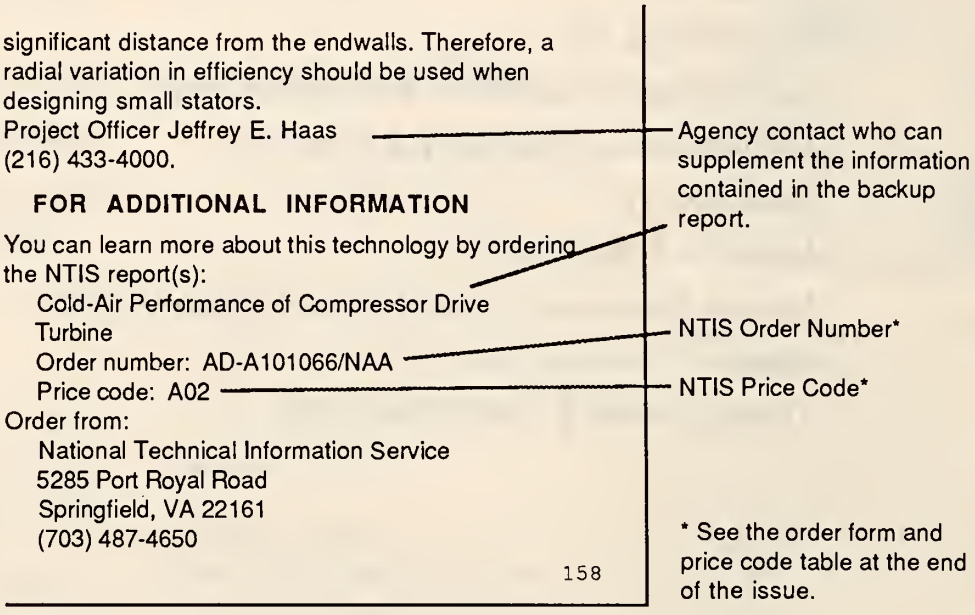
Each fact sheet also is perforated to allow for easy removal for those subscribers who may wish to keep a special fact sheet file or route to others in their organization

Sources of Further Backup Information

Below are two representative examples of how each Tech Note fact sheet provides you with a source of further information. In most cases, this information is provided directly by the agency or its laboratory.

However, there are cases where NTIS is the source for backup documentation. In these cases, use the order form at the end.

Examples:


significant distance from the endwalls. Therefore, a radial variation in efficiency should be used when designing small stators.
Project Officer Jeffrey E. Haas
(216) 433-4000.
FOR ADDITIONAL INFORMATION
You can learn more about this technology by ordering the NTIS report(s):
Cold-Air Performance of Compressor Drive Turbine
Order number: AD-A101066/NAA
Price code: A02
Order from:
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5285 Port Royal Road
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158
Agency contact who can supplement the information contained in the backup report.
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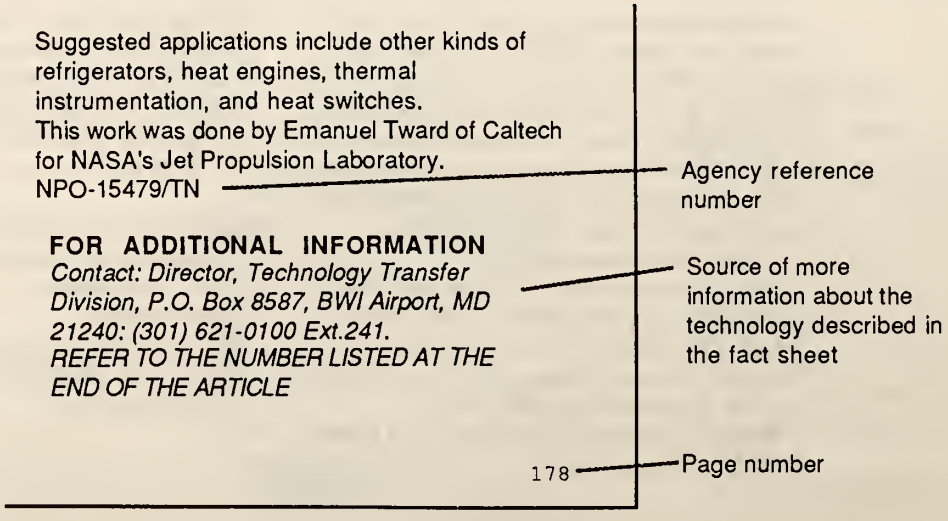
* See the order form and price code table at the end of the issue.


Suggested applications include other kinds of refrigerators, heat engines, thermal instrumentation, and heat switches.
This work was done by Emanuel Tward of Caltech for NASA's Jet Propulsion Laboratory.
NPO-15479/TN
FOR ADDITIONAL INFORMATION
Contact: Director, Technology Transfer Division, P.O. Box 8587, BWI Airport, MD 21240: (301) 621-0100 Ext.241.
REFER TO THE NUMBER LISTED AT THE END OF THE ARTICLE
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Agency reference number
Source of more information about the technology described in the fact sheet
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0486 Stabilizing Silicon-Ribbon Growth at Early Stages—A simple mechanism prevents silicon buttons from tipping. (Licensing Opportunity)
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Research Technology
Agricultural Research Service
U.S. Department of Agriculture

New Lure Attracts Medfly Males

A new and longer lasting lure for trapping the Mediterranean fruit fly (medfly) may become an important defensive weapon for California and other states that are susceptible to invasions of this destructive insect.

The new formula, Ceralure, lasts at least twice as long as the most widely used lure—Trimedlure—according to ARS scientists Terrence P. McGovern, a research chemist at Beltsville, Maryland, and Roy T. Cunningham, a research entomologist at Hilo, Hawaii. They took the name for their new formula from the scientific name for medfly, *Ceratitis capitata*.

Ceralure might be used inside thousands of traps that agricultural agents in states such as California, Texas, Arizona, and Florida hang on trees in prime, multibillion dollar crop-growing areas. They monitor traps year around to detect immigrant medflies.

Invasions that aren't zapped in time cost millions in eradication expenses and lost sales of fresh fruits and vegetables.

That's why, when 31 medflies showed up in traps during a single week in west Los Angeles last fall, agricultural agencies hurriedly fought back with sterile flies and insecticides, stopping what might otherwise have become a major outbreak.

Medflies could easily adapt to living in states that offer a mild, sunny climate, and an abundant supply of some of the more than 250 different crops the flies can infest.

McGovern and Cunningham replaced Trimedlure's chlorine atoms with iodine atoms and changed its alcohol component from a four-carbon to a more stable two-carbon component. They also rearranged the ratio of what are known as isomers, so that Ceralure has a greater proportion of the isomer that proved to be the best attractant.

Ceralure's ability to stay "fresh" longer than Trimedlure means traps should need to be replenished with the new chemical less often. Impressive savings in labor costs could result for states like California, which maintains 30,000 medfly traps.

The new attractant is made in the laboratory using readily available chemicals that are heated under pressure, then purified. Ceralure's chemical name is ethyl 4(and 5)-iodo-trans-2-methylcyclohexanecarboxylate.

Experiments planned for Hawaii should show how well the new lure performs in modern plastic dispensers, which may replace cotton wicks saturated with lure.

Mediterranean fruit fly. (PN-7279)

FOR ADDITIONAL INFORMATION: For technical information about this patent, contact Terrence P. McGovern, USDA-ARS, Insect Chemical Ecology Laboratory, Room 3, Bldg. 010, BARC-West, Beltsville, MD 20705; (301)344-2138. Patent No. 4,764,366, "Persistent Attractants for the Mediterranean Fruit Fly, the Method of Preparation and Method of Use." For information of licensing this patent, contact CUFT patents listed on this page or to receive a catalog of USDA patents, contact Ann Whitehead, coordinator, National Patent Program, USDA-ARS, Room 401, Bldg. 005, Beltsville, MD 20705. Inquiries concerning rights for commercial use of this invention should be addressed to: Office of Federal Patent Licensing, Center for the Utilization of Federal Technology, Room 304, NTIS, Springfield, VA 22161; (703)487-4738. Refer to Patent 4,764,366/TN.

Oil from Meadowfoam Plants

From a distance, it looks like a canopy of white foam rising gently from a rich green valley. But to the growers of meadowfoam, a low-growing winter annual, what counts most is not the flower but the valuable oil cached away inside the plant's seeds.

"The flowers look brilliantly white, almost unnaturally so," says Marvin Ringsdorf, a meadowfoam grower in western Oregon. "But as pretty as they are, that's just not where the money lies."

The seeds are pear-shaped, striated, and tiny; they look like miniature spurs. These thin hulls encase a most unique oil, a rich source of long-chain fatty acids, not found in other commercial oils, that can easily be made into soap, hair-care products, and moisturizers. Meadowfoam oil may also have potential in the production of industrial lubricants, polymers, waxes, and lactones. Researchers say it is one of the most stable vegetable oils known.

In the period 1984-86, the Oregon Meadowfoam Growers Association sold 12 tons of the oil to the Japanese cosmetics industry. A smaller amount was sold to Canadian firms, and samples were sent to the European Economic Community. Despite its promise, though, future use of the plant remains uncertain, says Dave Nelson, the association's executive secretary.

"The largest single deterrent to the successful marketing of meadowfoam oil is its cost," he says. "And that's tied to the small yield we've experienced to this point."

While meadowfoam yields about 1,000 pounds of seed per acre, the seeds (called nutlets) produce only 20 to 30 percent oil.

"Like the laser in its early days," Nelson says, "the great promise of meadowfoam inspires lots of speculation, but we have to admit that its best uses have probably not been uncovered."

Scientists with USDA's Agricultural Research Service have been struggling with that matter on and off for nearly 30 years. At the Northern Regional Research Center in Peoria, Illinois, meadowfoam seed oil was first examined in the late 1950's. Analyzing the oil was part of a program to search for new industrial raw materials from plants.

Today, meadowfoam *(Limnanthes alba)* is part of an energetic new crops program headed by chemist Robert Kleiman at the Peoria lab. Along with two full-time researchers, Kleiman explores industrial applications for meadowfoam oil.

"Very simply stated, our objective is to commercialize the oil," he says. "And the way we hope to do that is by making products that are better than those that are currently found in industry.

"We don't expect that all of the potential applications we find will be

KAREN PARKER

Nutlets contain 20 to 30 percent oil. Scientists would like to increase this yield.

DAVE KING/OREGON STATE UNIVERSITY

White flowers contrast with the pear-shaped seed pods (right). The seed oil can be used in industrial lubricants, polymers, waxes, and lactones.

used. But we want people to get interested in what we may be able to do with the oil, be it lubricant or cosmetic base."

Kleiman's samples of oil come from the Oregon Meadowfoam Growers Association, with which ARS has a memorandum of understanding to collaborate in exploiting meadowfoam oil. The agency also operates under a cooperative agreement with Oregon State University, where plant scientist Gary Jolliff and others are attempting to increase the amount of seed oil yield per acre.

Although native to the Pacific Northwest and Vancouver Island, British Columbia, meadowfoam has been grown to a limited extent in parts of the eastern United States, Alaska, and western Europe. "It is definitely not limited to any single area of the country," Kleiman says.

Normally planted in the fall and harvested in early summer, meadowfoam is best suited to mild climates where soil temperatures for germination range from 40°F to 60°F. The plant is 10 to 18 inches tall at maturity.

FOR ADDITIONAL INFORMATION: Robert Kleiman is in the USDA-ARS New Crops Research Unit, Northern Regional Research Center, 1815 N. University St., Peoria, IL 61604 (309) 685-4011.

Research Technology
Argicultural Research Service
U.S. Department of Agriculture

Acetic Acid Produced from Corn Sugar

William L. Bryan at the Agricultural Research Service is beginning work to develop a new process for recovering acetic acid from corn sugar fermentation. Besides being the main ingredient in ordinary vinegar, acetic acid is the expensive part of a compound, calcium magnesium acetate or CMA, that the Federal Highway Administration says is an excellent alternative to road salt.

"More economical acetic acid could clear the way for wider use of CMA as an alternative to deicing salts," Bryan says. He's optimistic about developing a process to reduce the cost of making CMA and will pursue any patentable ideas from the research.

Commercial CMA, tested by several states, is made by reacting petroleum-based acetic acid with lime products. This acetic acid accounts for 85 percent of CMA's 34-cents-a-pound price tag, he says.

CMA has been made from corn-based acetic acid only on a limited experimental scale. With large-scale production, Bryan estimates cost will be in the range of 10 to 15 cents per pound by the new process. "Partly, of course, it would depend on the price for corn. But the advantage of corn is that it's a renewable resource, unlike petrochemicals. And there's more often a corn surplus than a shortage."

Acetic acid for food-type vinegars is made through yeast and bacterial fermentations of sugar from corn or other plants. But Bryan will use a different bacterium, Clostridium thermoaceticum.

"This bacterium is promising because it yields about 45 percent more acetic acid than the typical vinegar fermentation process," says Bryan. The higher yield should help reduce CMA's cost."

FOR ADDITIONAL INFORMATION: To discuss this effort further, contact William L. Bryan, chemical engineer, Agricultural Research Service, USDA, Northern Regional Research Center, Peoria, Ill. 61604; (309)685-4011, ext. 414.

Computers

0429 Read/Write Optical Data Storage (Licensing Opportunity)

0430 CD-ROM Speech Database Available

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0432 Scheduling Tasks in Parallel Processing—Algorithms are sought to minimize the time and cost of computation.

Software

0433 Computer Model Evaluates Security System Effectiveness

U.S. Navy Technology Application

Read/Write Optical Data Storage

A technique for writing, reading and erasing optically stored data has been developed. Data stored by optical means (similar to laser discs) in a ferroelectric polymer is chemically and physically stable over periods of years. This technique uses the ferroelectric properties of the polymer to provide the mechanism for data storage. Data is entered by a pulse from a laser diode in the presence of an applied field. Data readout and erasure is also performed optically.

STAGE OF DEVELOPMENT

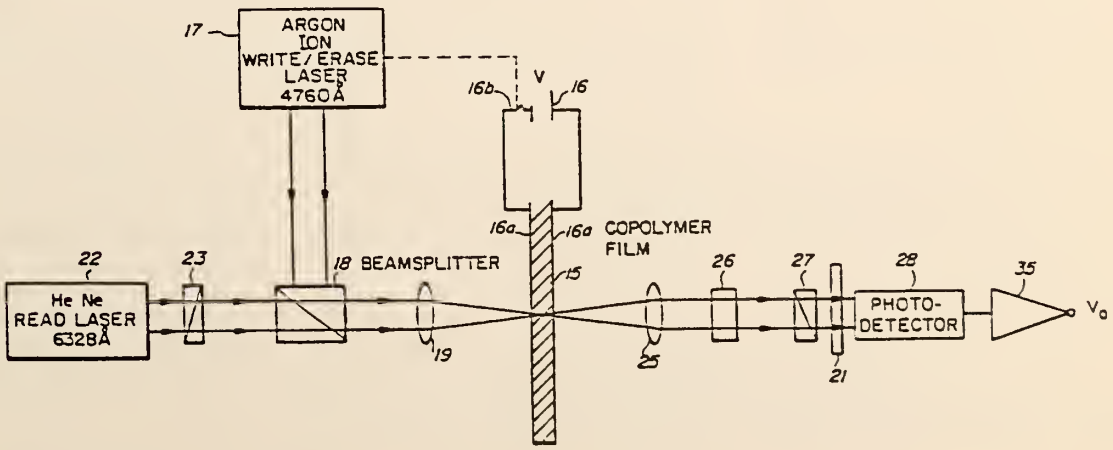
The method has been verified experimentally in the laboratory.

RELATED US PATENT # 4,731,754

PUBLICATIONS

"Ferroelectric Polymer as an Optical Memory Material," T.R. Ogden and D.M. Gookin, Materials Letters, V.3, p. 127 (1985).

"Electro–optic Hysteresis in Polyvinylidene Fluoride," D. Gookin and R. Morris, Appl. Phys. Lett., 45(6), 603(1984).



ADDITIONAL INFORMATION

D.M. Gookin, Naval Ocean Systems Center, Code 761 T, San Diego, CA 92152. Telephone: (619) 553–2538.

NIST Technology Update

National Institute of Standards & Technology
(Formerly the National Bureau of Standards)
U.S. Department of Commerce, Gaithersburg, MD 20899

CD-ROM Speech Database Available

As part of its speech recognition research to help computers become better listeners, researchers in the NIST National Computer Systems Laboratory have produced the first speech database in this country in CD-ROM (compact disk read-only memory) format.

The database consists of digitized speech data for 420 talkers speaking 4,200 sentences. NIST has been working with private industry and the Defense Advanced Research Projects Agency to develop ways - such as this database - to measure the performance of speech recognition systems. Texas Instruments, the Massachusetts Institute of Technology, and SRI International collaborated with NIST to produce this CD-ROM database.

FOR ADDITIONAL INFORMATION: A limited number of discs are available from David Pallett, NIST, A216 Technology Bldg., Gaithersburg, Md. 20899; 301/975-2035.

Effectiveness of a Writing System Using a Computerized Long-Range Optical Pointer and 10-Branch Abbreviation Expansion

Many individuals with limited abilities require specialized technological writing systems. These individuals and the clinicians and engineers who work with them need information regarding the effectiveness of various systems. This study developed a methodology for assessing the effectiveness of a technological writing support system and evaluated its success. The Long-Range Optical Pointer and 10-Branch Abbreviation Expansion System developed at the Trace R&D Center at the University of Wisconsin was used. The study applied a single subject research design: a series of AB replications with naturally-occurring baselines comparing data within subjects across behavior, and across subjects. Behaviors assessed included typing rate, efficiency, and accuracy. The results demonstrate the effectiveness of this system with four individuals with severe physical disabilities and one able-bodied person. Among the data collected, typing rates were found to range from 3 to 15 words per minute, with suspected dependency on familiarity with the system. Discussion highlights the potential benefits of this system and the critical requirement to individually assess a person's needs in order to appropriately select and prescribe these types of technology.

FOR ADDITIONAL INFORMATION: To discuss this effort further, contact Roger O. Smith, Trace Research and Development Center, S-151 Waisman Center, University of Wisconsin-Madison, Madison, WI 53705.

NASA Tech Brief
National Aeronautics and Space Administration

Scheduling Tasks in Parallel Processing

Algorithms are sought to minimize the time and cost of computation.

A report describes research on the scheduling of computational tasks in a system of multiple identical data processors operating in parallel. To take advantage of parallelism, tasks should be distributed over as many processors as possible. However, the overhead of communication among distributed tasks may outweigh the improvement in performance achieved through the use of multiple processors. The requirement that some tasks be completed before others are begun limits further the degree to which parallel processors can be employed effectively.

The effectiveness of a given assignment of tasks is measured in terms of two numerical criteria: the cost of communication based on the total exchange of data among tasks and the total execution time. If no processor is idle until it has completed all its tasks, then the total execution time of the system is simply the total execution time on the most-heavily-loaded processor. The strategy in assignment is to minimize a weighted sum of these communication and execution costs.

The computational intractability of this problem in minimization requires the use of suboptimal heuristic algorithms in all but the most trivial cases. The authors describe four such methods.

The first, called the "list heuristic," is a variation on classical list scheduling. In the first phase of the list heuristic algorithm, tasks are sorted in order of increasing total communication. The rationale is that because the assignment of the first tasks will not be based on costs of communication with other tasks, they should be the tasks that communicate the least, so that in scheduling one ignores as little information as possible. In the second phase, a feasible partial solution is iteratively expanded into a complete schedule. Each task from the ordered list is scheduled on a processor at the earliest time, such that communication with assigned tasks is minimized and such that constraints on precedence are not violated.

The second algorithm, called the "cluster heuristic," can be applied to tightly coupled tasks and consists of four phases. In the first phase, a list is made of pairs of tasks that communicate, and the list is sorted in order of decreasing pairwise communication, so that tightly coupled tasks are considered first during the next phase. In the second phase, n clusters of tasks are built; a cluster is associated with each processor. As pairs of tasks are considered, if neither task is assigned, both are placed on the least-loaded processor (i.e., in the smallest cluster). If one task is assigned, the other is assigned to the same processor unless a specified load threshold has been exceeded, and in that case it is placed on the least-loaded processor. Load balancing is intended to prevent large clusters that would result in the poor utilization of parallel processing.

In the third phase, the tasks within each cluster are ordered with respect to the constraints on precedence, so that each cluster represents a feasible sequence of tasks. In the fourth phase, subsequences of tasks are shifted to later times to enforce the constraints on precedence among tasks that belong to different clusters.

The third algorithm, called the "exchange heuristic," is an iterative-improvement algorithm that may begin with any initial feasible assignment of tasks to processors and periods of time. Pairwise exchanges of tasks are then performed (with the goal of decreasing the costs of communication) until no further advantageous exchanges are possible, a principle that has been used successfully in solving the traveling-salesman problem and other classical combinatorial problems. At each iteration, a selection is made of that pair, the exchange of which would yield the greatest improvement in the objective. The exchange is made if the constraints on precedence are not violated.

The fourth algorithm is an iterative one for the optimal assignment of tasks and is based on a concept called "simulated annealing" because of its mathematical resemblance to aspects of physical annealing processes. A conventional iterative algorithm usually converges to a local optimum (as measured by the weighted-cost function). In anticipation of finding a more global optimum, the simulated-annealing algorithm probabilistically accepts configurations of assignments that temporarily degrade the quality of the system.

The acceptance probability is a function of the change in the cost function and a parameter analogous to the temperature in a physical annealing system. As the parameter is slowly reduced, fewer nonimproving changes are accepted. Thus, a coarse global search evolves into a fine local search for optimality, and the probabilistic "jumps" provide escapes from nonglobal optima.

This work was done by Camille C. Price of Stephen F. Austin State University and Moktar A. Salama of Caltech for **NASA's Jet Propulsion Laboratory**. *"Scheduling of Precedence-Constrained Tasks on Multiprocessors," NPO-17219/TN*

FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*
REFER TO THE NUMBER LISTED AT THE END OF THIS ARTICLE

Department of Energy

Technology Application

Sandia National Laboratory

Computer Model Evaluates Security System Effectiveness

A personal computer program has been developed at Sandia National Laboratories for evaluating the effectiveness of security systems. Developed under the sponsorship of the U.S. Department of Energy (DOE), the program is now being used by various facilities that must safeguard nuclear material and information.

The program is a computer model that calculates the effectiveness of physical protection systems against a spectrum of theft and sabotage threats from intruders and suggests improvements where necessary. Named Systematic Analysis of Vulnerability to Intrusion (SAVI), it analyzes potential theft and sabotage attacks where intruders are interrupted at the target, as well as theft attacks where the intruders are contained within the site boundary. The program evaluates security system effectiveness against attackers on foot, in a land vechicle, or in a helicopter.

The path-analysis model operates on a personal computer and calculates the 10 paths to any given target that are considered to have the most security weaknesses. The paths are ranked in order of their potential vulnerability to 0intruders. The computer model calculates a measure of security system effectiveness called "probability of interruption"-the probability that intruders would be detected and engaged by a facility's response force before the theft or sabotage mission could be completed.

Alfred Winblad of Sandia's Safeguards Engineering Department was instrumental in developing the model. He says it is being used extensively to evaluate the effectiveness of security systems at Sandia and at other facilities run by or for DOE. The DOE is responsible for coordinating the design and production of nuclear weapons.

"The SAVI model is one of many tools and techniques that DOE facilities use to evaluate nuclear security systems," Winblad says. "However, we believe it is proving to be a particularly valuable tool. Using it makes us re-think our security systems and discover potential weaknesses that can be corrected to make strong systems even stronger."

Before the model is used, the site-specific threat must be defined by adversary types, their objectives, and capabilities. In all cases, attackers are assumed to have supporting equipment and explosives.

To calculate the 10 paths with the most vulnerabilities, SAVI analyzes the physical protection system and the paths a adversary might take to a target. The interactions of delay, detection, and response functions of security systems are also considered.

The physical protection system is modeled using an adversary sequence diagram, in which an adversary attempts to defeat various security elements. Fifteen basic protection elements are considered by the model, including guarded and unguarded fences, doors, gates, tunnels, and isolation zones.

Winblad says SAVI can quickly and easily be used to produce a list of potential security system improvements for the most vulnerable paths once the program models and analyzes the existing system.

Since 1973, Sandia has been the lead laboratory for DOE research and development in physical protection systems for nuclear facilities. SAVI was recently taught to about 250 persons responsible for security at various DOE installations.

SAVI was developed by Winblad and several others in Sandia's Nuclear Security Systems Directorate. Richard McAniff was the design project leader for SAVI, which evolved from another vulnerability model that Winblad and Miller Cravens developed several years ago for use on mainframe computers. The personal computer coding for SAVI was done for Sandia by Science & Engineering Associates, Inc. of Albuquerque.

FOR ADDITIONAL INFORMATION: Public Information Division, Code 3161, Department of Energy, Sandia National Laboratories, Albuquerque, NM 87185-5800; (505)844-4207. Refer to announcement 24, No. 1.

Electrotechnology

0434 Characterizing TEM Cells

0435 Electrostatic Discharge Susceptibility Data VZAP-2

0436 An Inexpensive Rapid Annealing Apparatus (Licensing Opportunity)

0437 Integrated Optical Time Domain Reflectometer (OTDR) Insertion Loss Measurement System (Licensing Opportunity)

Testing & Instrumentation

0438 Measurement or State-of-the-Art Integrated Circuits

0439 Design and Analysis of Optical Communication Links—The signal-to-noise ratio alone does not indicate the level of performance.

0440 Spread of Charge from Ion Tracks in Integrated Circuits—Single-event upsets spread to adjacent memory cells.

0441 Processing SAR Images on Board—Images would be produced faster and data-transmission requirements would be reduced.

0442 Testing Fixture for Microwave Integrated Circuits—Devices can be characterized repeatably and nondestructively. (Licensing Opportunity)

0443 Trends in Susceptibility to Single-Event Upset—Data are compiled from several sources.

NIST Technology Update

National Institute of Standards & Technology
(Formerly the National Bureau of Standards)
U.S. Department of Commerce, Gaithersburg, MD 20899

Characterizing TEM Cells

NIST has pioneered in the use of transverse electromagnetic (TEM) cells for the generation of standard electromagnetic (EM) fields. Electronic equipment and/or components are inserted into TEM cells and tested for susceptibility to or emission of EM radiation. The cells are also used to calibrate portable probes for the measurement of EM fields. A new publication, Generation of Standard Electromagnetic Fields in a TEM Cell (TN 1319), documents the facilities and procedures used by NIST to generate these EM fields. In addition to advantages, limitations, and characteristics of TEM cells, the publication dicusses setup and measurement procedures for users, uncertainties in the standard field, and statistical control of the system. Twelve references are reproduced to provide the details of material summarized in the text.

FOR ADDITIONAL INFORMATION: A copy of the report is available from NTIS, Springfield, VA 22161; (703)487-4600.

NTIS order number: PB161632/NAC

Purchase Code: A03

Technology Assessment
U.S. Air Force

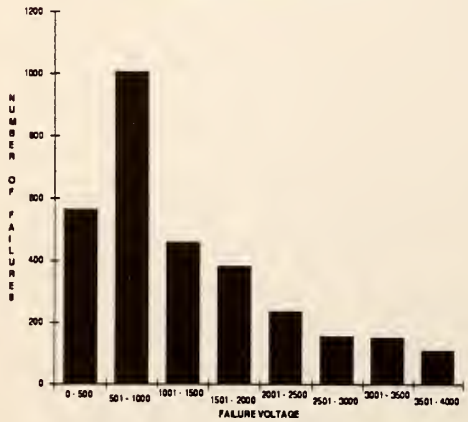
Electrostatic Discharge Susceptibility Data VZAP-2

RAC is planning to publish an updated databook on electronic component electrostatic discharge susceptibility. This databook, VZAP-2, will contain data on approximately 1600 microcircuits and 900 discrete semiconductor devices and represents efforts by RAC to improve its VZAP database by increasing the quantity and quality of the data contained in it.

The purpose of this document is to make available electrostatic discharge susceptiblity test and classification data which has been collected over the past several years.

As an example, the following figure depicts the failure voltage distribution for CMOS IC's.

MOS FAILURE VOLTAGE PROFILE



Knowledge of the ESD susceptibility levels of devices being handled or assembled is essential to the establishment of an effective ESD control program.

Without this type of information, there is little basis to purchase and implement ESD control products, often resulting in insufficient ESD control on an "overkill" situtation.

This databook will be an update to the 1983 RAC document VZAP-1, which has been widely used throughout the electronics industry to obtain ESD susceptibility levels of electronic components.

VZAP-2 data, compiled from data submitted by manufacturers, end users, and test laboratories. Each data record is based upon a complete understanding of susceptibility test methods and tester equipment, the number of devices failed, actual fail voltage, the typical pin combination which proved to be most sensitive, and the criteria which was used to determine the device failure.

Also contained in VZAP-2 is the classiification of each device, per DoD-STD-1686A.

In addition to detailed susceptibility data and classification data, VZAP-2 also contains discussions on how to interpret the data. Also contained are failure voltage distributions for various IC technologies as well as discrete semiconductor part types.

VZAP-2 is available from the RAC, prepaid at $125 U.S. and $135 Non-U.S.

For Additional Information, contact:

Reliability Analysis Center
P.O. Box 4700
Rome, NY 13440-8200
(315) 330-4151

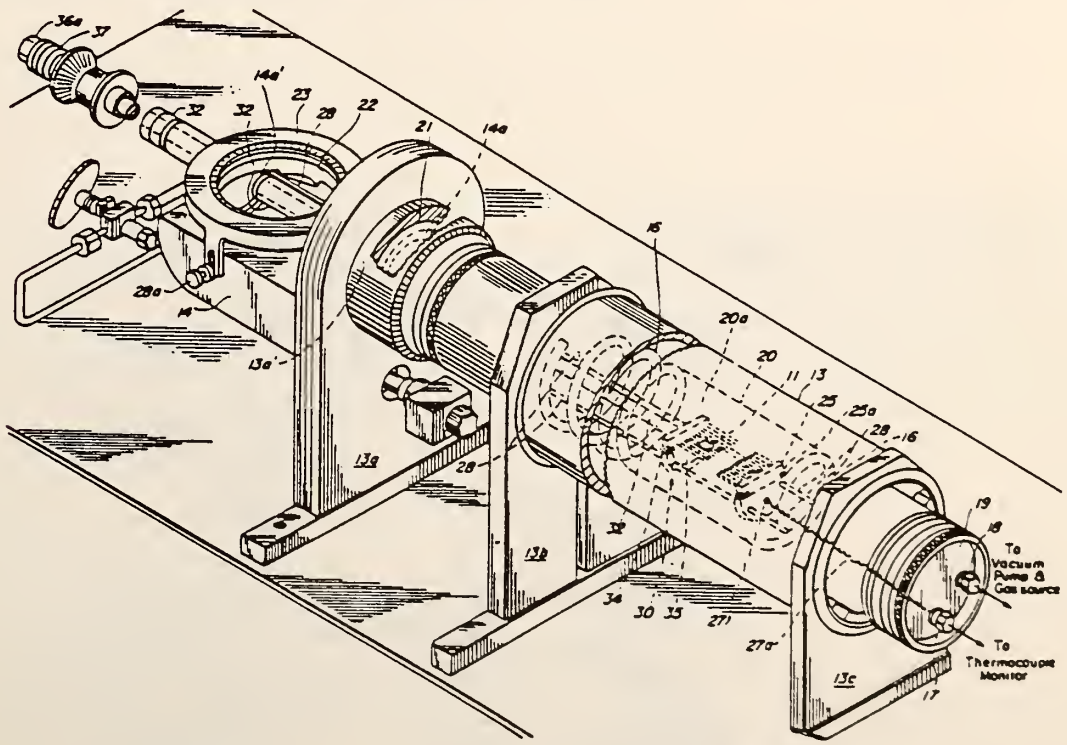
U.S. Navy Technology Application

An Inexpensive Rapid Annealing Apparatus

After semiconductors are ion implanted they must be annealed to remove the ion damage and promote electrical conduction. In many cases, it is good to anneal rapidly. For example, the shorter the time at the final temperature, the less motion the implanted impurities will undergo. Or, if the problem is to anneal ohmic contacts to a semiconductor, the less time spent at the final temperature, the less the metal will evaporate or bubble up.

This apparatus will allow annealing to temperatures as high as 725 degrees C for times as short as 10 seconds. The warm up and cool down times are about 15 seconds each. While heating, the sample is held in an ambient such as pure argon or hydrogen, not just ordinary air which might oxidize the sample.

The apparatus is relatively inexpensive to build. The temperature is accurately known. These are positive attributes. The negative features are: (1) shorter times than 15 seconds are not practical, and (2) temperatures higher than about 725 degrees C are not possible.



STAGE OF DEVELOPMENT

This apparatus has been built and works fine for indium phosphide implants and ohmic contacting.

APPLICATIONS

This apparatus is good for semiconductors such as indium phosphide and mercury cadmium telluride which benefit from processing at and below about 700 degrees C. Silicon and gallium arsenide require higher temperatures than this, so they can't be used very well as the apparatus now stands.

PATENT STATUS
A patent has been awarded. PATENT 4,721,836

PUBLICATIONS

D. L. Lile, D. A. Collins, and C. R. Zeisse, "Transient annealing of indium phosphide", IEEE El. Dev. Lett. EDL-4, 231 (1983).

ADDITIONAL INFORMATION

Contact C. R. Zeisse, Code 561, NOSC, San Diego, CA 92152-5000. His telephone is 619-553-5705.

U.S. Navy Technology Application

Integrated Optical Time Domain Reflectometer (OTDR) Insertion Loss Measurement System

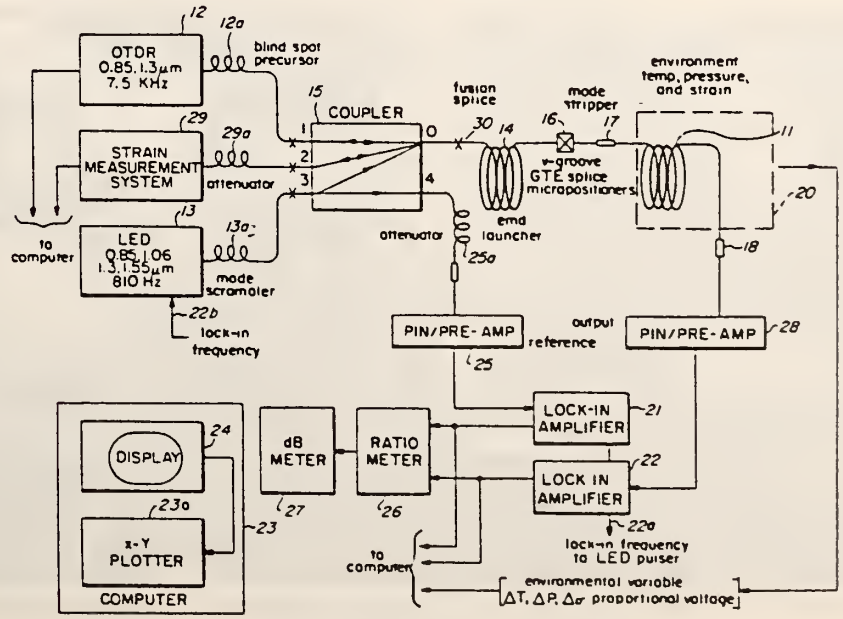
A multiport fiber optic coupler combines an optical time domain reflectometer, an optical strain gauge, and an insertion loss measurement system to evaluate environmental stress effects on fiber optic cable. The OTDR measures cable attenuation and provides a visual readout of the modal distribution launched into the test fiber.

STAGE OF DEVELOPMENT

The system has been successfully demonstrated in the lab. A prototype system is presently used at NOSC , Code 946.

APPLICATIONS

The integrated measurement system has application in the area of fiber optic cable environmental testing.



PATENT STATUS

United States Patent Number: 4,685,799 August 11, 1987

PUBLICATIONS

The concept and results were published:"Integrated OTDR/throughput loss measurement system for environmental testing of cabled optical fibers", SPIE Proceedings, San Diego, Vol. 559, August 21-22, 1985, pp. 88-94

Additional Information

M.R. Brininstool, Code 946, Naval Ocean Systems Center, San Diego, CA 92152-5000. Telephone : (619) 553-1952

Navy Manufacturing Technology

Automated Manufacturing Research Facility

National Institute of Standards & Technology
Formerly the National Bureau of Standards (NBS)
U.S. Department of Commerce, Gaithersburg, MD 20899

Measurement or State-of-the-Art Integrated Circuits

The new NIST optical system is capable of untended operation and should reduce certification time for standards from five days to twelve hours. Researchers have also recently developed and documented a model for the calculation of optical microscope images. The features on photomasks are calibrated by measuring light coming through a transparent mask. Features on wafers must be calibrated using reflected light, a much more complicated problem. NIST researchers have produced a model which can form the basis for the optical measurement of micrometer and submicrometer lines on integrated circuit wafers, and have published it in the form of a computer program and its documentation.

As another part of their effort to address industry's needs, NIST is developing new systems that will be able to make accurate measurements further into the submicrometer region. Current optical systems are useful only to about 0.5 micrometer. Measurement of features as small as 0.1 micrometer requires accuracy in the nanometer range, or to an accuracy of just a few atoms. For measurements in that range, use of the Scanning Electron Microscope (SEM) is required.

NIST researchers have modified an SEM for submicrometer dimensional metrology. A custom-designed specimen stage has been built which allows the specimen to be scanned under a stationary electron beam. The scanning motion of the specimen is measured directly by an optical interferometer to a precision of

NIST PHYSICIST JAMES POTZICK IS SHOWN HERE WITH THE OPTICAL SYSTEM FOR CALIBRATING PHOTMASK STADARDS WHICH HE DESINGNED

better than 0.008 micrometers. This innovative movement of the specimen stage eliminates the need to depend on calibration and linearity of the electron beam scanning system of the conventional SEM. In addition, an etching process was developed that modifies the existing NIST pitch (magnification) standard for SEMs and allows this standard to be used at the lower beam voltages currently being used in the semiconductor industry. Lower beam voltages are important because high voltages can damage the semiconductor specimen.

NIST researchers are currently developing a lithographically defined magnification standard on a silicon wafer.

Development of measurement techniques and standards for the semiconductor industry appears to be a never-ending task that is always playing "catch-up ball" to the technology of actually making smaller structures. As NIST researchers look to the 1990's they envision a whole new set of requirements for linewidth standards.

NIST has pioneered in the use of transverse electromagnetic (TEM) cells for the generation of standard electromagnetic (EM) fields. Electronic equipment and/or components are inserted into TEM cells and tested for susceptibility to or emission of EM radiation. The cells are also used to calibrate portable probes for the measurement of EM fields. A new publication, Generation of Standard Electromagnetic Fields in a TEM Cell (TN 1319), documents the facilities and procedures used by NIST to generate these EM fields. In addition to advantages, limitations, and characteristics of TEM cells, the publication dicusses setup and measurement procedures for users, uncertainties in the standard field, and statistical control of the system. Twelve references are reproduced to provide the details of material summarized in the text.

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NASA Tech Brief
National Aeronautics and Space Administration

Design and Analysis of Optical Communication Links

The signal-to-noise ratio alone does not indicate the level of performance.

A report presents a method of design and analysis of an outer-space optical communication link that uses pulse-position modulation (PPM) and in which the received signal is sufficiently weak to require detection by a photomultiplier operating in the photon-counting mode. In such a system a traditional intuitive understanding of radio-frequency communications does not lead to an adequate method of design and analysis. Although the bit signal-to-noise ratio suffices to rank the performance of a radio-frequency system, the performance of an optical system depends on the signal and noise powers in a more complicated way. The report is an attempt to convey to prospective designers an intuitive understanding based on the unique characteristics of optical communication systems.

The dominant limitation on performance is usually not due to noise originating in the receiver (as in the radio-frequency case) but rather is due to the received background noise. Because of this and because of the peculiarities of photon-counting statistics, an evaluation of performance involves the following three basic steps.

Step 1 requires some knowledge or assumptions about the parameters of the transmitter and receiver. The average number of signal photons detected per signal pulse is calculated from the size of the receiver aperture; the energy of each pulse; the divergence of the transmitted light beam; the wavelength; the transmission distance; the quantum efficiency of the detector; and attenuation in the transmitting optics, the receiving optics, and the atmosphere.

Step 2 is the determination of the average number of background-noise photons detected during a PPM timeslot. This number depends on the slot time; the receiver characteristics considered in step 1; the size of the receiver field of view; and the sizes and luminosities (at the designated wavelength) of stars, planets, or other optical-noise sources within the field of view.

In step 3 the average number, P_S, of signal photons detected per signal pulse is compared with the average number, P_N, of noise pulses detected per PPM timeslot. To enable an assessment of performance, the comparison is made by reference to a plot of the P_S that would be required to achieve a given bit-error rate at a given P_N: this plot is a function that depends on the particular PPM code. If the data are transmitted in a Reed-Solomon or other error-correcting code, the required P_S is lower.

The three steps would ordinarily be performed in the above order in the analysis of an existing or proposed system. However, the steps can be performed in any order suitable to a specific task: for example, in designing a system that must achieve a specified bit-error rate, noise-photon figure, or signal level, it is best to do step 3 first.

This work was done by J. R. Lesh, W. K. Marshall, and J. Katz of Caltech for **NASA's Jet Propulsion Laboratory**.
"A Simple Method for Designing or Analyzing an Optical Communication Link"

NPO-17017/TN

FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*
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NASA Tech Brief
National Aeronautics and Space Administration

Spread of Charge From Ion Tracks in Integrated Circuits

Single-event upsets spread to adjacent memory cells.

Single-event upsets (SEU's) — which are reversible changes in logic states, caused by impacts of heavy ions — can propagate to adjacent cells in integrated memory circuits. This is one of the findings of experiments in the lateral transport of electrical-charge carriers from ion tracks in 256K dynamic random-access memories (DRAM's). As the dimensions of integrated circuits decrease, the vulnerability to SEU's increases. The understanding gained through this and future studies may enable the design of less vulnerable circuits.

An energetic ion that strikes an integrated-circuit chip perpendicularly to its surface produces electrons and holes along the ion track. If the track intersects a charge-collecting junction, some of the charge is collected promptly along the track with the help of electric-field-funnel transport. However, if the track is longer than a few microns, the electric field is restored to its original configuration (the funnel collapses) before all the charge is collected, leaving the remaining charge to diffuse outward from the track in all directions. Furthermore, if the ion track does not intersect a charge-collecting junction, nearly all of the charge diffuses outward.

The portion of the charge that diffuses to (or along) the surface of the chip can be captured by other charge-collecting junctions, possibly causing SEU's in the memory cells containing those junctions. DRAM's are particularly suitable for measurements of this phenomenon, because maps of bit errors around ion tracks in these circuits are direct indications of which memory cells have received at least the critical charge, Q_C, for SEU. For example, in one experiment, bit errors occurred in a cluster of eight memory cells, one of which was struck by a 168-MeV bromine ion. This is consistent with independent measurements that show that the cross section for SEU by a 168-MeV bromine ion is eight times the area of one cell in the particular memory circuit.

The critical charge of a DRAM cell is given by $Q_C = C(V_{DD} - V_B)$ where C = the cell storage capacitance, V_{DD} = the supply voltage, and V_B = the input bias voltage of the sensing amplifier. Thus, the vulnerability of the cells to SEU can be increased or decreased by adjustment of V_{DD} or V_B. This makes it possible to extract more information from ion-impact tests by expanding or shrinking clusters of bit errors around a single ion track or by inferring a "gray-scale" map of the charge distribution about a single track from measurements about multiple tracks.

This work was done by John A. Zoutendyk, Harvey R. Schwartz, and R. Kevin Watson of Caltech, and Leland R. Nevill of Micron Technology, Inc., for **NASA's Jet Propulsion Laboratory**.

"Lateral Charge Transport From Heavy-Ion Tracks in IC Chips,"
NPO-17265/TN

FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*
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NASA Tech Brief
National Aeronautics and Space Administration
NASA's Jet Propulsion Laboratory, Pasadena, California

Processing SAR Images on Board

Images would be produced faster, and data-transmission requirements would be reduced.

A proposed synthetic-aperture radar (SAR) processor would operate aboard the moving radar platform, turning the raw signal data into images of the scanned terrain. In conventional SAR systems, the raw data are either transmitted to stations on the ground or else recorded on magnetic tape by high-density digital recorders (HDDR's) for subsequent processing on the ground. The principal advantages of the proposed system are that it would make SAR images available almost immediately and that the processed data to be transmitted or recorded would be only about one-fifth as voluminous as the raw data. Onboard image compression could reduce the volume of data even further.

The processor would generate four-look imagery from the raw data by use of a time-domain parallel-accumulator approach. In most SAR processors, the correlation of the radar signals with the range response functions is performed before the correlations with the azimuth response functions because doing so eases the flow of data and the correction for range migration. In this processor, the number of azimuth correlators (and, therefore, the power and weight of the system) would be reduced by performing the azimuth correlation first.

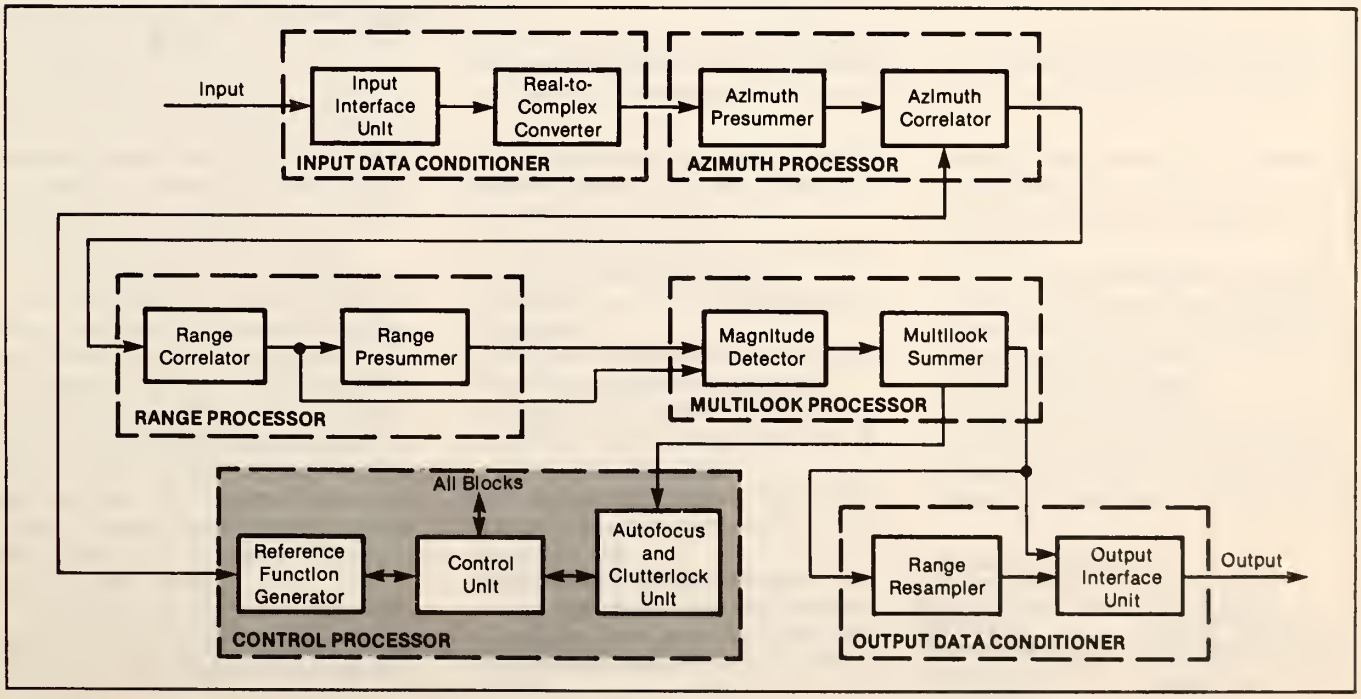
The six functional elements of the conceptual SAR processor are the input data conditioner, the azimuth processor, the range processor, the multilook processor, the output data conditioner, and the control processor (see figure). The control processor is connected to the other functional elements through a control bus.

The input data conditioner reduces the rate of the SAR echo data. It receives the raw digital SAR signal from a real-time radar source or from a HDDR on board. It synchronizes the echo and radar-pulse signals, extracts position and scanning information from the header on the raw data signal, and converts the input real data samples into complex-arithmetic samples for use by the azimuth processor.

The azimuth processor includes two single-look parallel modules, each of which consists of an azimuth presum filter and an azimuth correlator. Each presum filter applies a filtering operation to consecutive samples, then performs downsampling to reduce the data rate by a factor of 3. Each azimuth correlator removes the effect of range walk and range curvature, then performs the azimuth compression necessary to achieve the desired azimuth resolution.

Each of the two azimuth outputs is sent to one of two modules in the range processor. Each module contains a range correlator, which performs the range compression necessary for the desired range resolution. At high look angles, the range-correlator output is sent through the range presummer, which extracts two range looks and feeds the results to the multilook processor. At low look angles, the output of the range correlator is divided into two subswaths and sent directly to the multilook processor.

The multilook processor includes the magnitude detector, which detects the complex magnitude of the correlated data.



The **Onboard SAR Processor** would form images of the scanned terrain, thereby reducing the amount of data to be stored or transmitted.

It also includes the multilook summer, which incoherently sums all range and azimuth single-look data to obtain the multilook images.

The output data conditioner consists of the range resampler and the output interface unit. At low look angles, where the range pixel spacings are finer than required, the conditioner reduces the output pixel spacings so that the number of samples per range line can be kept constant. At high look angles, the output of the multilook summer is sent to the output interface unit directly, bypassing the range resampler. The output interface unit merges the output-header and synchronization-code information with the processed images from either the range resampler or the multilook summer (depending on look angles).

The control processor consists of the autofocus and clutterlock unit, the reference-function generator, and the control unit. The autofocus and clutterlock unit tracks the Doppler frequency and the change in the rate of change of the Doppler frequency from the multilook data. The reference-function generator generates the azimuth reference function needed for azimuth compression, based on the Doppler parameters received from the control unit. The control unit generates the processor-configuration-control information and the range reference function based on the received header data. It also estimates the new Doppler frequency and the rate of change of the Doppler frequency, based on the data received from the autofocus and clutterlock units.

This work was done by Kuang Y. Liu and Wayne E. Arens of Caltech for **NASA's Jet Propulsion Laboratory**.

NPO-17195/TN

FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*

REFER TO THE NUMBER LISTED AT THE END OF THIS ARTICLE

NASA Tech Brief
National Aeronautics and Space Administration
Lewis Research Center, Cleveland, Ohio

Licensing Opportunity

Testing Fixture for Microwave Integrated Circuits

Devices can be characterized repeatably and nondestructively.

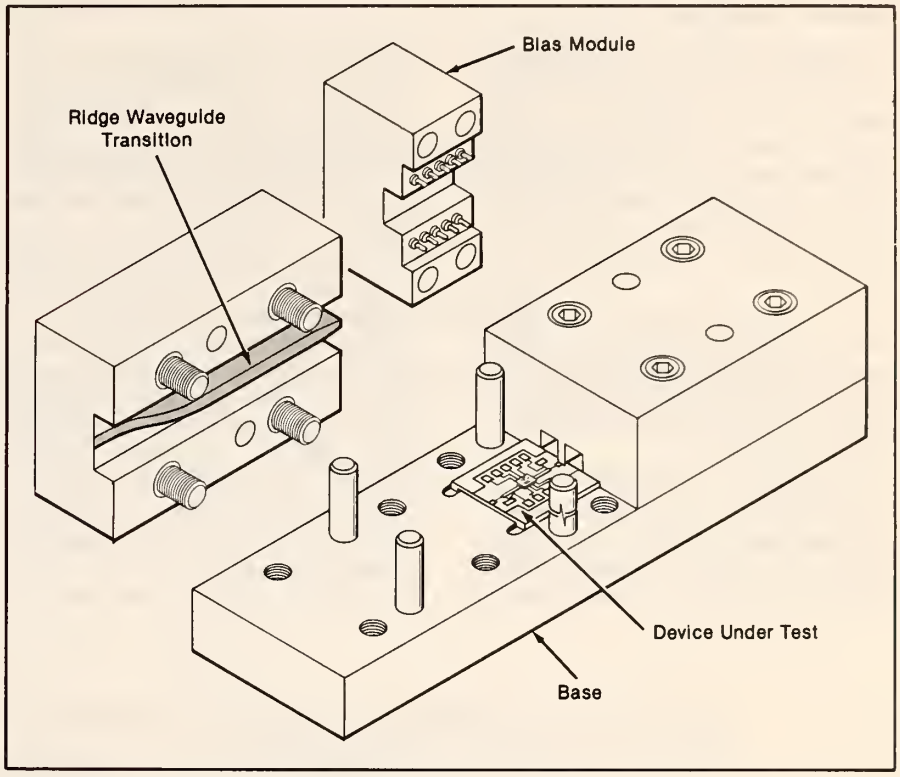
A testing fixture facilitates the radio-frequency characterization of microwave and millimeter-wave integrated circuits. The fixture is intended to be used in conjunction with an automatic network analyzer to provide the user with deembedded scattering parameters of the device under test. The fixture has been demonstrated to operate from 26.5 to 40.0 GHz, and operation can be extended to much higher frequencies.

Previous fixturing techniques have employed various styles of transitions from test-system transmission media to the device under test, each such technique possessing some favorable attributes as well as significant limitations. These limitations include nonrepeatability, complexity, and narrow bandwidth. In addition, these techniques are often destructive to the devices and tend to be labor-intensive. Furthermore, no known existing test fixture permits chip-level characterization above 26.5 GHz.

In an effort to enhance the performance of the new fixture, the number of its components was minimized. The fixture includes a base onto which two cosine-tapered ridge waveguide-to-microstrip transitions are fastened (see figure). The length and profile of the taper have been determined analytically to provide maximum bandwidth and minimum insertion loss. Each cosine taper provides a transformation from high impedance of the waveguide to the characteristic impedance of the microstrip.

The integrated circuit is mounted on a customized carrier, which is inserted between the bottom of the ridge and the base of the waveguide. The electric field is concentrated by the ridge and launched onto the microstrip via direct pressure contact. The carrier provides isolation between the device under test and the test fixture as well as bias-control circuitry. Control voltages are applied to the carrier by use of a self-aligned bias module with integral spring-loaded contacts.

A "through, short, delay" calibration algorithm is used to extract the scattering parameters of the device. The basic calibration establishes an ancillary reference plane that subsequently can be shifted to the terminals of the device.



The **Testing Fixture** for microwave integrated circuits provides improved contact, repeatability, matching of impedances, and nondestructive mounting of the device under test.

The unique features of this fixturing technique include the following:

- Operation is over the full bandwidth of the waveguide.
- The system is characterized at the level of the chip at millimeter wavelengths.
- Nondestructive contact is made to the carrier for both radio-frequency and direct-current connections.
- The mechanically simple design lends itself to rapid characterization of the device under test.
- Only one set of calibration standards is required, regardless of the size of the die.
- Calibration coefficients are transferred to the network analyzer so that radio-frequency measurements can be viewed in "real time."
- All network-analyzer features are maintained.
- The software is independent of frequency.

This work was done by Robert Romanofsky and Kurt Shalkhauser of **Lewis Research Center**. *No further documentation is available.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Lewis Research Center Refer to LEW-14746/TN

Lewis Research Center
Technology Utilization Officer: Daniel G. Soltis
Mail Stop 7-3
21000 Brookpark Road
Cleveland, OH 44135
(216) 433-5567

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Gene E. Shook
Mail Code 301-6
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FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*
REFER TO THE NUMBER LISTED AT THE END OF THIS ARTICLE

NASA Tech Brief
National Aeronautics and Space Administration

Trends in Susceptibility to Single-Event Upset

Data are compiled from several sources.

A report provides a nearly comprehensive body of data on single-event upsets due to irradiation by heavy ions. The report combines new test data and previously published data from governmental and industrial laboratories. Clear trends that emerge from the data should be useful in predicting the future performances of devices.

The data are arranged in two tables. Table 1 lists data for 104 metal-oxide/semiconductor (MOS) and metal-nitride-oxide/semiconductor (MNOS) integrated circuits. Table 2 gives data for 82 bipolar integrated circuits.

Each circuit is described by function, fabrication technology, manufacturer, testing organization, number of bits or gates, linear energy transfer threshold, device upset cross section, and upset cross section per bit. A remarks column notes the presence of latchup and anomalies.

The most important fact that emerges from the tabulated data is that most of the MOS devices [except negatively-doped-channel MOS (NMOS) devices] are less susceptible to single-event upset than are other types of devices. Almost all the bipolar devices, except logic devices of the 54XXX family, are more susceptible.

Both complementary metal-oxide/semiconductor (CMOS) and bipolar read-only memories (ROM's), including programmable ROM's, are subject to apparent upsets even though they have no circuit elements with bipolar states. Radiation-hardened parts (resistant to high total doses) are sometimes more resistant to single-event upsets.

Electrically alterable ROM's made by MNOS technology are not subject to soft errors, but they may be permanently damaged by heavier ions. The probability of damage increases with the frequency of erasing and writing because permanent damage can occur only when a high electric field is present in the gate insulator.

This work was done by Donald K. Nichols and William E. Price of Caltech, Wojciech A. Kolasinski and Rukotaro Koga of The Aerospace Corp., Alvin E. Waskiewicz of Rockwell International Corp., and James C. Pickel and James T. Blandford of IRT Corp. for **NASA's Jet Propulsion Laboratory**.

"Trends in Parts Susceptibility to Single Event Upset From Heavy Ions,"

NPO-17147/TN

FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*
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Energy

0444 Computerized Utility Cost-Reducing Procedure is Available

0445 Lightweight Nickel Composite Electrode (Licensing Opportunity)

0446 Residential Energy Conservation Shared-Savings Program

0447 Use of Evaluation Results in Bonneville Power Administration's Planning Models

0448 Shedding New Light on Ways to Cut Energy Dollars

Testing & Instrumentation

0449 New System Tracks Air Flow Quicker, Better

0450 Evolution of Cenospheres—Microscopy reveals changes in structure during combustion.

NAVY
Domestic Technology Transfer Fact Sheet

Computerized Utility Cost-Reducing Procedure is Available

An Activity-Level Energy System Planning (A-LESP) Procedure has been developed by the Naval Civil Engineering Laboratory, Port Hueneme, California. First developed for hand calculations, the computerized version will drastically reduce the time needed to complete an energy study. The procedure is an effort to identify probable energy options. This planning tool, with its logical step-by-step procedure, is designed to help untangle the many intertwined energy management factors and associated decisions.

The results of the A-LESP procedure are in tabular format and can be used to develop an energy plan. The results can also suggest more intensive energy investigations, and can help verify estimates performed by independent contractors. Although the procedure is fully developed, new options will be added as new technologies are proven.

For Additional Information:

Backup material on this effort is available from:

Navy Domestic Technology Fact Sheet Reader Reply Service
Code E211
Naval Surface Weapons Center
Dahlgren, VA 22448-5000
(703) 663-8921

Refer to 140203/TN

U.S. Navy Technology Application

Lightweight Nickel Composite Electrode

Sintered nickel battery electrodes are heavy, structually weak and expensive. A new process shows the potential for a successful high energy density, electrically durable light-weight nickel composite electrode fabricated by a relatively simple suspension method of active material impregnation. The electrodes have use in fuel cells and chloralkali cells.

The electrode represents the results of several years of developmental research. A significant advance in energy storage capability of the nickel oxide electrode used in Ni-Cd, Ni-Fe, Ni-Zn, and Ni-H2 cells, has been achieved by the development of a porous sintered, nickel-plated graphite fiber plaque impregnated by the electrochemical process.

The electrode grip consists of a sintered mat or felt of graphite fibers which are coated with a mixture of nickel and phosphorous. The electrode grid is strong, lightweight, and has good electrical performance.

Single electrode test cells have displayed high working energy densities of 120 to 180 Ah/kg. Lifetimes of 500 to 600 cycles for c rate and greater than 1000 cycles at one half c rate of discharge have been achieved.

Utilization of active material approaches 100% in lightly loaded electrodes (<1.5 g/cc void) and range from 70% to 90% in those more heavily loaded (1.5 to 2.0 g/cc void). A region of increasing utilization was observed in every case extending sometimes to 200 cycles. With later modification to the method of additive addition, the utilization increase became much more rapid.

The nickel composite electrode approach appears to offer promise for a new generation of economical, lightweight Nickel alkaline battery systems.

FOR ADDITIONAL INFORMATION: To discuss this effort further contact Dr. William Ferrando, NSWC/WO, Code R32, Naval Surface Warfare Center, Silver Spring, Maryland 20903-5000; (202)394-3527. PATENTS 4,574,096 and 4,215,190 have been issued.

Oak Ridge National Laboratories

Residential Energy Conservation Shared-Savings Program

Research was undertaken to evaluate the effectiveness of a novel residential energy conservation shared-savings program: the Residential Energy Conservation Action Program (RECAP). This program was administered in 1983 and 1984 by the General Public Utilities Corporation (GPU) through contracts with energy service companies. Contractors installed energy retrofit measures in all-electric homes of GPU customers in four communities in New Jersey and Pennsylvania. The work was essentially free to homeowners. The contractors were repaid for their work by the utility on the basis of measured electricity savings.

The evaluation examined pre- and postretrofit electricity consumption for program participants and compared the results with the electricity consumption of matched control groups. To correct for variations in heating degree-days over time and across communities, a weather normalization technique was employed. Survey data from program participants were also analyzed.

Energy savings (in kilowatt-hours per year) were averaged across all four RECAP communities. Participating households conserved about 1600 kWh/year after retrofit. Because the control group's electricity consumption over the same period also decreased, the net savings (that which was attributable to RECAP) were reduced to about 1300 kWh/year, or 6.6% of the preretrofit level. As Fig. 1 illustrates, the estimates of total and net savings differ markedly across the four RECAP communities.

The amount of electricity savings is only weakly associated with installation costs, indicating that energy savings are not entirely predetermined by the cost of the retrofit work. The most expensive RECAP project (in York, Pennsylvania) had the greatest total and net savings. On the other hand, the least expensive RECAP project (in Covered Bridge, New Jersey) experienced twice the savings of the Leisure Village, New Jersey, project for one-half the cost per retrofit.

Multiple-regression analysis indicates that greater savings from participation in RECAP are associated with specific conditions at the time of

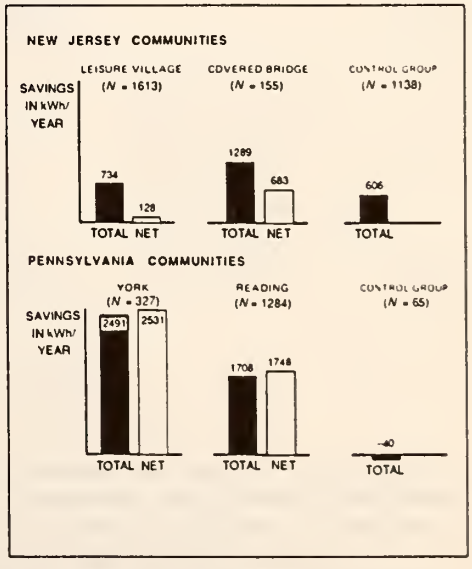


Fig. 1. Total and net energy savings in kilowatt-hours per year for four RECAP test communities and two control groups. The amount of total savings is the difference in normalized annual consumption between the preretrofit year (1982–83) and the postretrofit year (1984–85). Net savings equal the total savings of each community minus the total savings of the control group.

retrofit (higher levels of electricity consumption, larger households, and newer homes); certain changes since retrofit (fewer household members, decreased use of appliances, addition of a new source of nonelectric heat, and lower winter thermostat settings); and satisfaction with the program.

In addition, households treated by one of the contractors saved less. The lack of selectivity in choosing households to participate in RECAP distinguishes this contractor from the others and may account for its poor performance. The two New Jersey projects, which were retirement communities in contrast to the more heterogeneous Pennsylvania areas, also saved more.

The transferability of RECAP to other utilities and locales depends upon the value of kilowatt-hour and kilowatt savings in these areas and the costs of obtaining these through retrofit measures. As with most energy-conservation and load-management programs, RECAP appears to be most useful for utilities with high marginal fuel costs and projected near-term energy supply shortfalls. Residential shared-savings programs such as RECAP would also appear to be most desirable when a utility needs to achieve any of the following:

- improved customer relations,
- high penetration rates of residential retrofit measures,
- significant energy savings through weatherization of high-energy-consuming residences, or
- energy savings in retirement communities or other developments where the housing stock is uniform and homeowner motivation is low.

Additional information:

Office of Technology Applications
Martin Marietta Energy Systems, Inc.
P.O. Box 2008
Oak Ridge, TN 37831-6257

Telephone: (615) 574-4192; FTS 624-4192

Department of Energy

Technology Application

Oak Ridge National Laboratories

Use of Evaluation Results in Bonneville Power Administration's Planning Models

During the past decade, utility-sponsored conservation programs have become larger; more expensive; and, from a utility-system planning perspective, more important. As the importance of conservation programs has increased, utilities have focused increasing attention on demand-side planning and on treating conservation as a resource in load-forecasting models. Evaluations of the operation and performance of conservation programs provide information essential to these planning and forecasting activities.

The Bonneville Power Administration (BPA) has more information on conservation programs and their effects than most U.S. utilities because of its high level of program activity and its serious commitment to the evaluation of its programs. Therefore, BPA is an excellent choice for a study of how program evaluation data can be used in planning and forecasting models. The BPA modeling process has evolved into a highly complex structure. Documenting this structure enables researchers to (1) identify conservation's role in the modeling process, (2) understand how each model employs conservation data, and (3) critique the modeling process (Fig. 1).

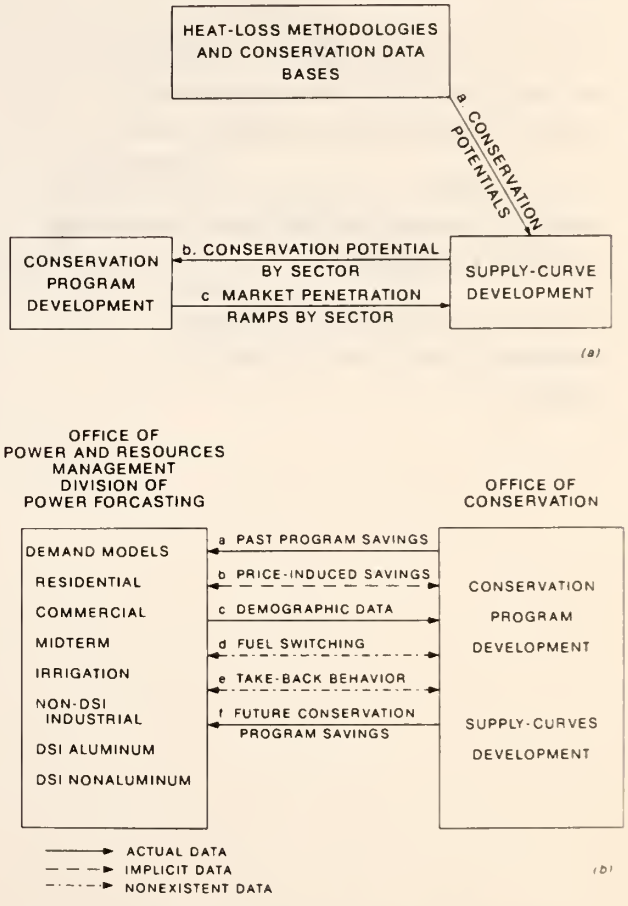


Fig. 1. Conservation data flow (*a*) within the BPA Office of Conservation and (*b*) between BPA's Division of Power Forecasting and its Office of Conservation. Direct service industries (DSIs) are industrial customers that sign separate contracts with BPA at negotiated rates and loads.

NIST Technology Update

National Institute of Standards & Technology
(Formerly the National Bureau of Standards)
U.S. Department of Commerce, Gaithersburg, MD 20899

New System Tracks Air Flow Quicker, Better

Knowing how air flows into, out of, and within a building is important information to those analyzing indoor air quality and energy use. Most techniques currently available either treat the building as a single, well-mixed volume of air or are complex, requiring the use of several different tracer gases. A new technique developed by researchers in the NIST Center for Building Technology uses a single gas to trace airflow between various "zones" or building areas. In field trials, the technique was quicker and more accurate than any previously used.

FOR ADDITIONAL INFORMATION: To discuss these efforts further, contact Andrew Persily, Research Building, Room A313, National Institute of Standards & Technology, Gaithersburg, MD 20899; (301)975-6418. Media Contact: Jan Kosko, (301)975-2762.

NASA Tech Brief
National Aeronautics and Space Administration

Evolution of Cenospheres

Microscopy reveals changes in structure during combustion.

Experiments have been performed to trace the evolution of the structures of droplets of burning fuel oil. Many droplets burn incompletely, forming cenospheres. Knowledge of the structure at various stages of the combustion process may contribute to efforts to design equipment that will burn the cenospheres.

The experimental burner was designed for No. 2 fuel oil but fed with No. 6 fuel oil, which is 500 times as viscous at room temperature. The oil was preheated to 380 °F (193 °C) to reduce its viscosity and sprayed in a cone 80° wide at a pump pressure of 130 psig (0.90 MPa). Residues that emerged from the flame were collected on glass plates.

The residues were coated with thin layers of gold/palladium alloy to enhance the reflection of electrons, then examined by scanning-electron microscopy. Several different types of particles were found, including partially-burned spherical oil drops, cenospheres. and clusters of bubbles. The partially-burned oil drops had very smooth surfaces and ranged in size from 40 to 60 μm. Most of the cenospheres had sizes ranging from 7 to 40 μm; some were larger than 70 μm. The cenospheres had pores of various sizes, indicative of degrees of disruptive motion of fuel vapor inside. Some holes contained pores within pores. Some cenosphere had fewer holes, possibly because they were not burned completely. Some cenospheres were covered with loose, fuzzy soot. The more porous cenospheres appear to be more completely burned. The residues also contained clusters of bubbles ranging in size from 80 to 130 μm.

Because large numbers of droplets are exposed to a variety of environments in and around the combustion zone, the observed structures are believed to represent all stages of the formation of cenospheres and suggest the following sequence of events. In a droplet destined to become a cenosphere, initially the volatile components at the surface and those that diffuse to the surface evaporate to form a diffusion-type flame. The removal of the volatile components leaves behind a viscous shell of asphaltene and resin. The shell slows further diffusion of volatiles; but as the temperature rises inside, additional volatile material vaporizes, causing the drop to expand. Eventually, the volatile material forces its way out, forming a blowhole in a weak spot of the shell. The shell then contracts by surface tension. At the end of vaporization, a hollow shell remains. Also, ejection of gaseous fuel may blow a part of the viscous surface of a drop into a bubble. Then the bubbles formed from the same or adjacent pores may coalesce, forming large clusters of bubbles.

This work was done by Eug Y. Kwack, Parthasarathy Shakkottai, Paul F. Massier, and Lloyd H. Back of Caltech for **NASA's Jet Propulsion Laboratory**. *"Particulate Structure in Heavy Fuel Oil Burner Experiments," NPO-17239/TN*

FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*
REFER TO THE NUMBER LISTED AT THE END OF THIS ARTICLE

Engineering

0451 Identifying the Root Causes of Field Failures

0452 Flow Regimes of Refrigerant Mixtures Condensing Inside Tubes

0453 New Device for Support of Cryogenic Transport System

0454 Tiny Microdryer "Sweats" to Keep Materials Water-Free

0455 Fins Reduce Ship Roll

Software

0456 Outdoor Lighting: This Lighting Design Package for Computer Vision Systems Makes Outdoor Lighting Design a Much Simpler Job

0457 ENDOW: An Application of an Expert System in Streambank Protection and Flood Control

Testing & Instrumentation

0458 New Calibration Services Users Guide

0459 Calculating Robot-Joint Coordinates from Image Coordinates—Detailed knowledge of the robot joints is not required.

0460 Beam Director for Optical Pyrometer—An instrument can "see" around bends.

0461 Control Algorithms for Liquid-Cooled Garments—Three schemes control the transfer of heat to and from the wearer's body.

0462 Numerical Modeling of Two-Phase, Reactive Flows—Capabilities of several computational schemes are combined and enhanced.

Other Items of Interest

0449 New System Tracks Air Flow Quicker, Better

Technology Assessment
U.S. Air Force

Identifying the Root Causes of Field Failures

There is a serious lack of field failure data available to industry and government. The data that does exist usually fails to track system failures to the individual piece part responsible for the failure, and even when data does exist, the cause of component failure cannot be determined. But why bother determining what causes a single component to fail, especially when the component costs only $2.00? From the life cycle standpoint it certainly pays to analyze many field failures. Estimates of the repair of fielded equipment range from $2,000 to $15,000 to identify, ship and repair a unit that has failed; therefore, if 100 parts fail, the cost of repair is not $200.00 but is closer to half a million dollars! And what if failure analysis determined that the cause of the component failure was due to improper component manufacturing procedures? When considering that this component may be used in hundreds of applications throughout the military, the cost of the failure is further compounded. But the real cost is not always measured in dollars. Every field failure means that at some point in time the equipment did not work, did not function as expected, or in some cases could have caused the loss of human life.

The Rome Air Development Center (RADC) initiated a pilot study in December 1986 to collect and analyze high failure rate microcircuits from operational aircraft. The program was designed to provide feedback to industry and to identify the root causes of field failures so corrective actions could be implemented. The results of this prototype program were astonishing. Estimated costs of corrective actions, cost of no corrective actions, and the actual cost of the analysis process were tracked to determine cost effectiveness. The potential payback was often one-thousand fold or greater. More importantly, without the analysis and corrective action process prototyped, neither the equipment user nor the original equipment manufacturer (OEM) had sufficient data to identify and

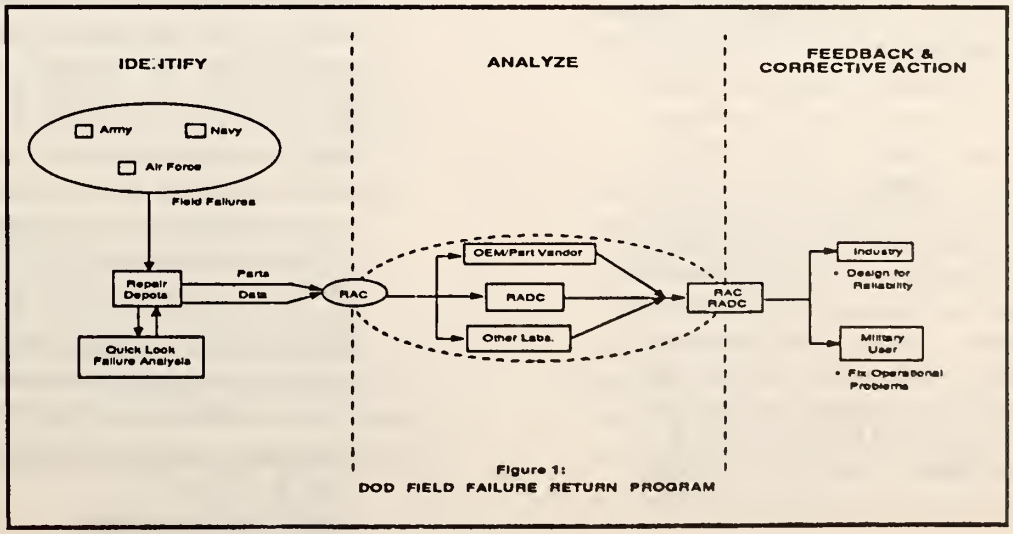


Figure 1:
DOD FIELD FAILURE RETURN PROGRAM

prioritize the sources of the problems, much less to correct them. RADC has since teamed with the Reliability Analysis Center to establish the DoD Microcircuit Field Failure Return Program (MFFRP) .

The long term goals of the MFFRP include the identification of high failure rate components, a determination of their root causes of failure using failure analysis, and the feedback of information to industry and government organizations so that appropriate corrective actions can be taken. To effectively accomplish these goals, three major tasks are required:

1. Collect failures
2. Analyze failures
3. Provide technical recommendations to guide the corrective actions

The mechanics of how these tasks will be performed are summarized in Figure 1.

The component failures being collected are from DoD systems. Equipment failures within the DoD are returned to depots where defective parts are identified and replaced, and the equipment is returned to inventory. Defective parts are typically discarded; however, high failure rate parts, high cost parts or mission critical components may be sent to an in-house lab for a "quick-look" failure analysis. The MFFRP provides a mechanism for a selective sampling of defective discards and all quick look failure analysis reports to be sent to the RAC. It should be noted that the MFFRP program does not alter the reporting procedures or repair process of any depot.

Unlike commercial suppliers, most military part vendors never see returns from the field unless a catastrophe occurs. Once a military system is in the field, no mechanism exists for routinely returning failed parts to the vendor. Most manufacturers welcome the opportunity to analyze their own parts and will usually perform this task for the DoD at no cost. Some vendors assume that because they do not receive field returns that their parts must be performing at a satisfactory level. The Microcircuit Field Failure Return Program, based upon the circumstances of the failed component, will arrange for failure analysis to be performed on a subset of the parts received. Analysis may be performed by the part manufacturer, the OEM, government labs, independent failure analysis labs, or by any combination of the above.

A valuable aspect of collecting field failure data through the MFFRP is that once the cause of failure is identified, feedback of information to the equipment user and manufacturer can be provided. This feedback can then guide the required corrective actions. In certain circumstances the distribution of the findings may be limited to the involved parties because of the commercial or military sensitivity of the data. But in all cases, the data will be made available to improve the product design and reduce costs and not to punish vendors for their past mistakes. All corrective actions made will be tracked. Currently the databases that exist in the DoD do not effectively track a system field failure to the individual part responsible for the failure. Current data sources cannot determine what is failing, at least not to the part level. The field data collected by the MFFRP can be used to assess the true reliability of electronic components. A small amount of quality data in conjunction with the proper statistics allows some general assessments to be made about piece part reliability.

The goals of the program can only be achieved DoD-wide through the coordinated efforts of each service. DoD repair centers will be responsible for identifying high failure rate piece parts and for collecting associated data, such as equipment type, usage information, etc. Each repair center should assign a point of contact for interface with the RAC. Through this point of contact, selected parts of special interest and failure analysis reports will be sent to the RAC to be logged and reviewed. The resulting reports, as well as recommended corrective actions will be distributed to the services, OEMs, and vendors for follow-up corrective action.

For Additional Information, contact:

Reliability Analysis Center
P.O. Box 4700
Rome, NY 13440-8200
(315) 330-4151

Oak Ridge National Laboratories

Flow Regimes of Refrigerant Mixtures Condensing Inside Tubes

Researchers in the Department of Mechanical and Industrial Engineering at the University of Illinois, under subcontract to ORNL, studied the behavior of nonazeotropic refrigerant mixtures in vapor-compression refrigeration systems. Theoretically, the use of these mixtures in a vapor-compression refrigeration system can reduce a compressor's work load when the temperatures of the fluid being chilled and the refrigerant fluid both change. However, this potential efficiency gain is compromised by degradation of the heat-transfer coefficients of these mixtures. For that reason, the researchers concentrated on understanding the phenomena responsible for the degradation of heat-transfer coefficients.

This research project produced three principal accomplishments: (1) it provided a means for visual observation and identification of the flow regimes in a refrigerant condenser for tests run with various R-12:R-114 mixture concentrations, (2) it led to the development of techniques for gas chromatography and sampling procedures, and (3) it contributed to understanding the mechanisms causing heat-transfer coefficient degradation of refrigerant mixtures.

The researchers built a condenser using alternating pieces of glass tubing and brass test sections contained in a clear plastic counterflow heat exchanger (Fig. 1). This arrangement enabled them to see and to photograph the complete process of condensation, from superheated vapor to subcooled liquid. It also allowed them to observe the effects that velocity, heat flux, and mixture concentrations have on various flow regimes. In addition, they monitored the condensing performance of refrigerant mixtures by means of thermocouple probes, pressure taps,

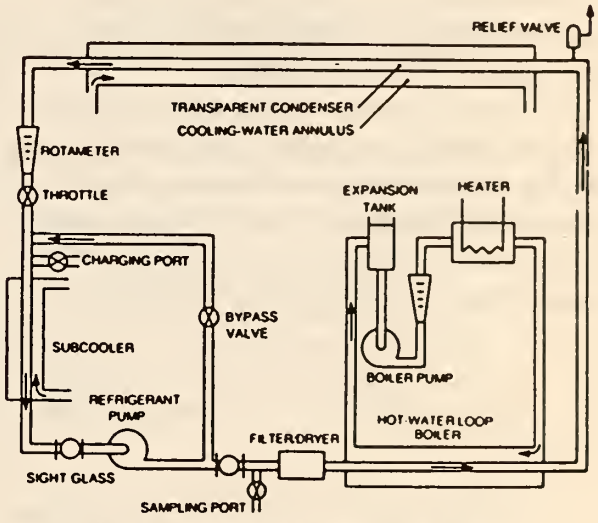


Fig. 1. The heat-transfer studies system. The component of special interest in this system is the refrigerant condenser. It is composed of twelve 1.5-m glass tubes (13-mm ID) connected by 165-mm brass test sections. Total length of the condenser is 20.7 m. This assembly is contained within a clear plastic annular heat exchanger (63.5-mm ID).

and sampling valves attached to the brass test sections.

Examining the flow regimes in this way enables an observer to better qualitatively interpret the heat-transfer characteristics of refrigerant mixtures. This information is also important to refrigeration research engineers who model heat-transfer processes. Samples are removed from test sites along the condenser tube and then analyzed (using gas chromatography) to quantify the extent of nonequilibrium between refrigerant vapor and liquid phases. Comparing the results of samples removed from different condenser locations can provide insights into the rates of condensation of various mixtures.

These observations also help to determine the cause of decreases in heat-transfer coefficients so that these causes can be eliminated. For example, the phenomenon of "slip" occurs when the mixture in the vapor phase moves at a greater velocity than that in the liquid phase. Vapor-liquid slip results in nonequilibrium of the two phases with respect to concentration as well as temperature. One possible solution, suggested by this research, is to place turbulence promoters in the refrigerant stream.

Additional information:

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

University of Illinois at Urbana-Champaign
Department of Mechanical and Industrial Engineering
1206 West Green Street
Urbana, IL 61801

E. Kornota and W. F. Stoeker, *Flow Regimes of Refrigerant Mixtures Condensing Inside Tubes,* ORNL/Sub/81-7762/4&01, Oak Ridge National Laboratory (June 1985).

Fermi National Accelerator Laboratory

New Device for Support of Cryogenic Transport System

Possibly the most demanding requirement for cryogenic-divice suspension systems is that they maintain position during shipping, installation, cooldown, and seismic excitation. They should also offer a high thermal impedance to heat conducted from the outside world.

A totally new cryogenic support system, developed by Fermilab scientists and engineers to meet these rigorous standards, has been granted a patent by the United States Patent Office and is now in the comm ercialization arena.

The Compact Cryogenic Support (CCS) provides a thermally efficient (low heat leak) structural connection for cryogenic devices. Thermal efficiency results from the use of low thermal conductivity materials configured with long heat transfer paths, along with effective heat intercepting and internal insulation. Structural integrity is assured by the use of high-strength materials having good cryogenic structural properties connected by effective, non-invasive thermal shrink fit junctions. The support is design-flexible and can be configured to function under tensile, compressive, flexural, or torsional loading, or any combination of these. Precision, high-quality mass producibilityy is achieved with components having simple geometries (cylinders, disks, and rings) and straight-forward assembly methods.

Central to the success of the CCS is the cryogenic support member. It relies on a metal-to-fiber transition joint which produces high-strength, high-reliability joints between fiber-reinforced plastic (FRP) tubes and metallic end connections made by a shrink-fit operation. By the proper determination of geometries, degrees of shrinkage, and construction temperatures and materials used, the Fermilab team has developed a joint that is good in tension, compression, flexure, and torsion; and generated excellent thermal contact between materials. This results in a very effective heat intercept. Further, this technique can be applied to a wide range of tube diameters.

Prototype joints have been made between G-10 compositte tubes to both aluminum and stainless steel end connections. Tests of these prototypes have established the joint's reliability and strength.

This new system, which is an element of the on-going Superconducting Super Collider dipole magnet development program, represents a significant departure from current superconducting-magnet design practice both in performance concept and meterials selection. The system eliminates the epoxy bond currently used in support consutruction. The joint becomes stronger as temepratures drop, and the FRP material strength is not reduced by penetrations.

The Fermilab Office of Research and Technology Application projects commercial potential for this device in the areas of fabrication of low heat-leak crostats for cryogen transport; magnetic-resonance imaging cryostats; medical accelerators; separation magnets; pulsed magnets for fusion; and cryogenic storage dewars. License opportunities are available.

FOR ADDITIONAL INFORMATION: Office of Research and Technology Applications, Fermi National Accelerator Laboratory, P.O. Box 500, MS 208, Batavia, IL 60510; (312)840-3333.

Lawrence Livermore National Laboratory

Tiny Microdryer 'Sweats' to Keep Materials Water-Free

Lawrence Livermore National Laboratory (LLNL) scientists, using advanced microengineering techniques, have developed a miniature (about the size of a dime) dryer to significantly improve the way electronic and other water-sensitive components are kept free of moisture. The inspiration was the human sweat gland! The microdryer uses a recently developed plastic, Nafion, similar to Teflon. Moisture causes the Nafion to conduct an electric current which electrolyzes the water into hydrogen and oxygen. The Nafion film is compressed between two porous nickel pellets so that one side is in contact with the outside atmosphere. On this side a thin film of fluorosilicone polymer, permeable to hydrogen and oxygen but not to water, allows these gases to escape while preventing water outside from leaking back in.

Water is a highly undesirable material inside many systems, particularly electronic components. However, because of imperfections in even the best seals, and "outgassing" of water vapor by construction materials, it is impossible to wholly avoid its presence. Traditional drying agents such as silica gels take up space and weight and their drying capacity is eventually exhausted. The LLNL microdryer, in contrast, is nonexhaustible.

The microdryer is small, simple rugged and remains unaffected at temperatures ranging from -70 to +100 degrees Centrigrade. While acting as a water remover, it also indicates the amount of water present by the current it draws. This sensor function can be very useful in detecting if a system has been mishandled, tampered with or damaged.

Several electronic firms are presently testing the microdryer as a simple, cost-effective way to maintain the reliability of sensitive electronic components. Recently, LLNL granted the Mayo Foundation of Rochester, Minn. the right to make and use 15 of its microdryers. They will be used to maintain low humidity around charge coupled devices which are prone to condensation problems when cooled to reduce their electronic noise. The CCDs are used in a closed circuit television system that is part of an X-ray tomography machine used to study the dynamics of the human heart.

FOR ADDITIONAL INFORMATION: Technology Transfer Programs, P.O. Box 808L-795, Livermore, CA 94550. (415)422-6416.

Fins Reduce Ship Roll

Throughout history, maritime designers have experimented with hull designs, outboard tanks, and all kinds of stabilizing systems to try to abate a ship's motion. The latest ship stabilizing system is designed to counteract shipboard roll through operation of movable fins projecting from the sides of the hull below the waterline. Working like wing flaps on jet planes, the 60-square-foot fins provide lift to counteract the rolling movement. The fins can reduce the amount of roll as much as 75 percent, depending on prevailing sea conditions and ship speed.

Fin movement is controlled by a variety of subsystems. The fins are positioned by hydraulic actuators in a power unit, but the brain of the whole system is a controller that hydraulically directs the fin movements.

Through ship speed and roll data, the controller commands the fins to counter the roll. The command is sent to hydraulic pump servo valves that cause hydraulic pressure to be applied to actuator pistons linked to the fins.

As the fins move, signals indicating fin position are sent back to a microprocessor and control stations located on the bridge and at the central-control stations. This all happens quickly causing the stabilizers to move almost constantly.

For Additional Information:

Backup material on this effort is available from:

Navy Domestic Technology Fact Sheet Reader Reply Service
Code E211
Naval Surface Weapons Center
Dahlgren, VA 22448-5000
(703) 663-8921

Refer to 140103/TN

NCEL Techdata Sheet

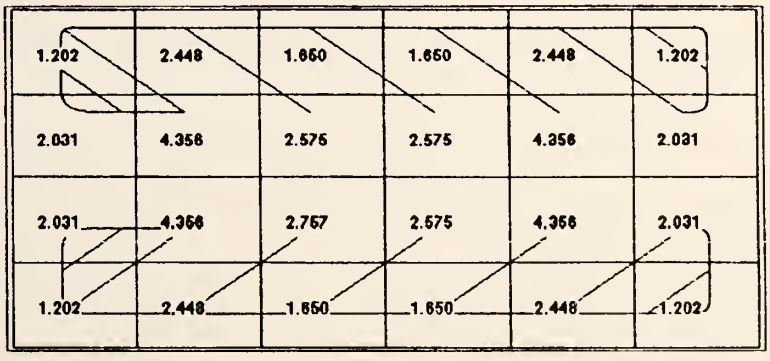
Software

NAVAL CIVIL ENGINEERING LABORATORY
PORT HUENEME, CALIFORNIA 93043

Outdoor Lighting: This Lighting Design Package for ComputerVision Systems Makes Outdoor Lighting Design a Much Simpler Job

Outdoor lighting design for security areas, sports fields, or parking lots is easily performed using Outdoor Lighting Design Software. Developed by NCEL's NAVFAC GEMS support team, this program determines the illumination levels for any number of luminaries (lights) placed in the area to be lighted. Virtually any configuration of luminaire arrangements and types can be accommodated. The user evaluates the computer-generated graphical output, and either keeps the configuration, if acceptable, or modifies it for a more desirable result.

Outdoor Lighting Design is a knowledge-based program for general outdoor lighting design that runs on ComputerVision systems using CADDS 4X Rev 5. It is based on the two most commonly used systems for flood-lighting calculations: point-by-point and beam lumen analysis methods. The program uses the finite element modeling feature of the computer program to accurately determine the illumination. All calculations follow the Illuminating Engineering Society of North America recommended guidelines. The program communicates to the user through a tablet menu and the display screen. After loading a lighting keyfile, the operator uses the digitizing pen and tablet to input the necessary data and run the program. All general luminaire parameters are automatically saved for reuse in a data file and the user doesn't have to enter them a second time.



The program works by first loading or generating a site plan of the area to be lighted. It then generates a grid to provide the cells for the finite element modeling (FEM) analysis program to use as points for calculating illuminance. If not already loaded in by the user, the specific luminaire parameters are then put in a PDATA file for the analysis program to use in the calculations. The designer then selects and places the luminaries at the desired location, height, and pointing angle. The illumination is compiled with the COMpile ILLumination command and a contour plot is made of the footcandle levels on the site plan section where the grid was made.

FOR ADDITIONAL INFORMATION: To discuss this effort further, contact: Jerry Dummer, Code L03C, Facilities Engineering Support Office, Naval Civil Engineering Laboratory, Port Hueneme, CA 93043; (805)982-4070. Refer to Techdata sheet 89-01/TN.

U.S. Army Corps of Engineers
Waterways Experiment Station
P.O. Box 631, Vicksburg, MS 39181-0631

ENDOW: An Application of an Expert System in Streambank Protection and Flood Control

A simple expert system, ENDOW (for Environmental Design of Waterways), has been developed to facilitate technology transfer to Corps field offices. ENDOW is useful for rapidly identifying environmental alternatives for inclusion in project plans, designs, or procedures for operation and maintenance. The current release of ENDOW contains modules for streambank protection and flood-control channel projects, and a draft version containing an additional module for levee projects is in review. When running ENDOW, a user answers queries from the program regarding the project setting and environmental objectives. ENDOW then responds with a list of project features for further study and possible inclusion. Help screens that provide detailed descriptions of features and information about cost and performance can be requested for any feature selected.

ENDOW runs on any personal computer with MS/DOS 2.0 or higher and at least 256 kilobytes of memory.

FOR ADDITIONAL INFORMATION: ENDOW may be obtained by sending a request along with a blank, formatted double-sided, double-density 5-1/4-inch floppy diskette to the US Army Engineer Waterways Experiment Station, ATTN: CEWES-IM-SC, PO Box 631, Vicksburg, MS 39181-0631.

NIST Technology Update

National Institute of Standards & Technology
(Formerly the National Bureau of Standards)
U.S. Department of Commerce, Gaithersburg, MD 20899

New Calibration Services Users Guide

The new NIST Calibration Services Users Guide 1989-1990 (SP 250) lists the calibration services, special test services, and measurement assurance programs (MAPs) available from NIST. The physical measurement services are designed to help the makers and users of precision measurements achieve the highest possible levels of quality and productivity. The hundreds of services described in the guide are the most accurate calibrations of their type available in the United States. They directly link a customer's precision equipment or transfer standards to national measurement standards. The calibrations and special tests include NIST services that check, adjust, or characterize instruments, devices, and sets of standards. The MAPs are quality control programs for calibrating a customer's entire measurement system. The guide also lists NIST technical experts who may be contacted for information on services and measurement problems.

FOR ADDITIONAL INFORMATION: For information on the NIST measurement services program, or to obtain a copy of SP-250, contact the Office of Physical Measurement Services, NIST, B362 Physics Bldg., Gaithersburg, MD. 20899; telephone: 301/975-2005.

NASA Tech Brief
National Aeronautics and Space Administration
Marshall Space Flight Center, Alabama

Calculating Robot-Joint Coordinates From Image Coordinates

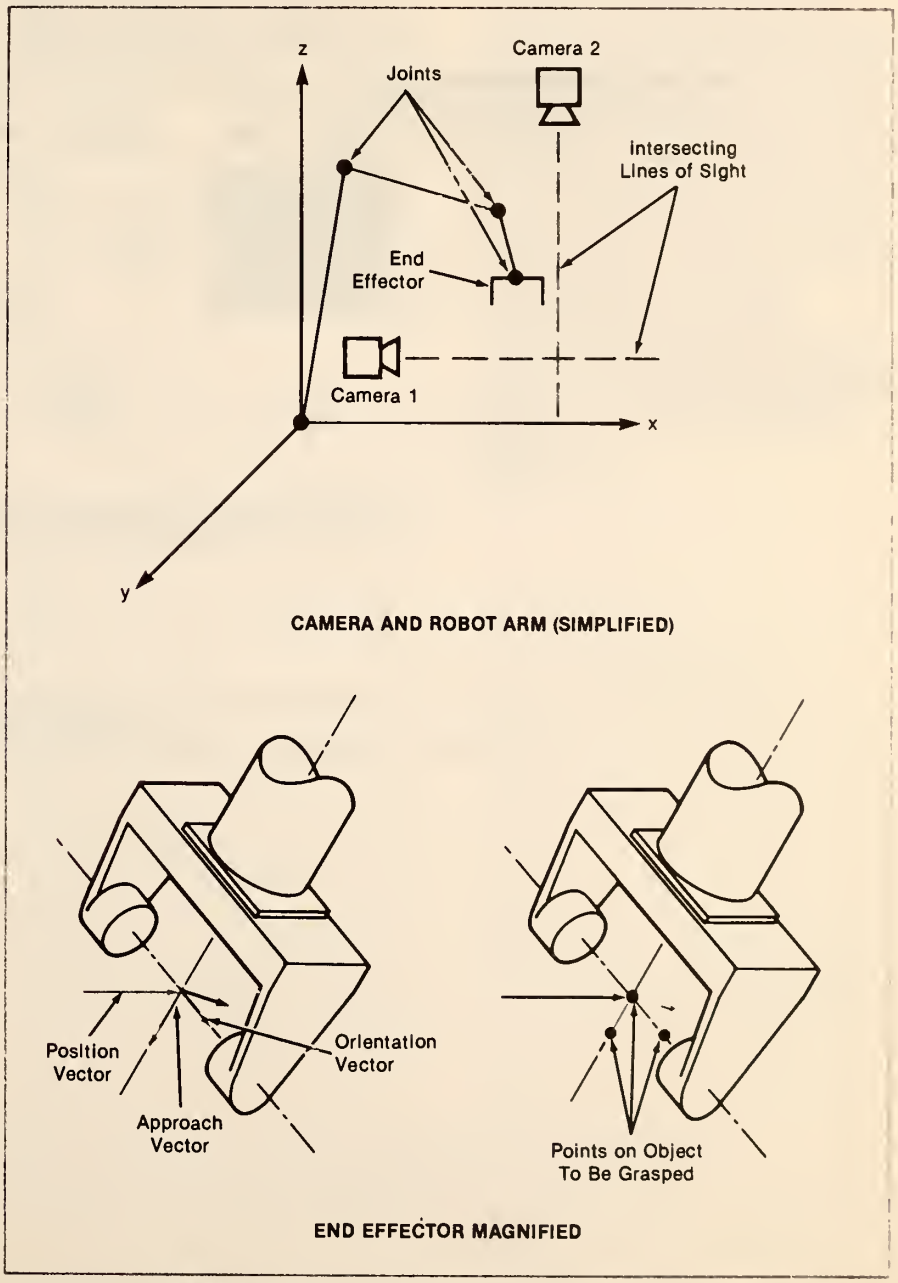
Detailed knowledge of the robot joints is not required.

An algorithm generates approximate mathematical models of the coordinates of the joints of a robot as functions of the coordinates of points in images of the work region viewed by television cameras. The same algorithm also generates such models as functions of the desired location of the end effector of the robot. The algorithm does not require a priori knowledge of the kinematic equations of the robot.

The image points in question are three points in or on an object viewed by two cameras set on perpendicular, intersecting lines of sight. In principle, the problem is to use the coordinates of these points in the images to generate their three-dimensional coordinates in the stationary Cartesian reference frame of the workspace; then to generate the required position, orientation, and approach vectors of the end effector in this same reference frame; and finally to find the robot-joint angles or linear extensions needed to position and orient the end effector to approach and grasp the object (see figure). It is also possible to bypass the workspace coordinates, transforming directly from image to robot-joint coordinates, and the algorithm is based on this approach.

The first step in the development of a model is to establish the robot kinematics experimentally by recording the end-effector and joint coordinates at many different positions and orientations. The mathematical model for each joint coordinate is a power series in the image coordinates of the three points. To reduce the number of computations to a manageable level, a comprehensive search is not conducted among all possible terms to determine which should be included in the model. Instead, the selection is limited to cross products of three or fewer image coordinates, the sum of powers is constrained to 4 or less, and the exponent of each coordinate must lie between -1 and $+3$.

Using the "append" method, a candidate term is appended to the model if it compares favorably with other candidate terms according to a least-squares or other performance index that measures the error between the measured coordinates and the coordinates predicted by the model. The process is repeated until the desired number of terms, n, is reached. The resulting n-term model is not necessarily optimum but is only the optimum model given the previous $n-1$ terms.



The Joint Coordinates necessary to position and orient the end effector are calculated by mathematical models fitted to experimentally determined data on positions, orientations, and joint coordinates.

The algorithm has significant advantages over prior analytical and iterative-transformation techniques. The models can be evaluated much faster than analytical joint equations because the models involve only numerical operations and no transcendental functions. The algorithm enables the models to adapt readily to changes in reference frames, robot configurations, grippers, and the like. It may enable the modeling of flexibility in robot links and of manufacturing errors, which are too complicated to model analytically. It may also provide closed-form solutions for joint coordinates that cannot be obtained analytically.

This work was done by Advanced Control Technologies for **Marshall Space Flight Center**.

MFS-27194/TN

FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*

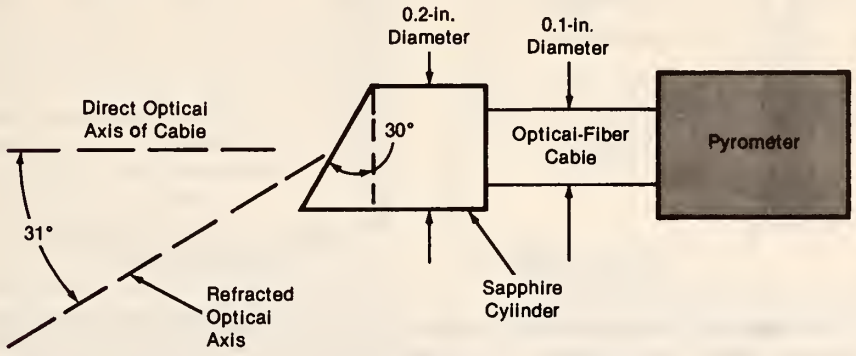
REFER TO THE NUMBER LISTED AT THE END OF THIS ARTICLE

NASA Tech Brief
National Aeronautics and Space Administration
Marshall Space Flight Center, Alabama

Beam Director for Optical Pyrometer

An instrument can "see" around bends.

An optical-fiber pyrometer under development will observe fields of view as much as 31° off axis. The pyrometer was designed to measure the temperatures of moving turbine blades in turbopumps; the pump configuration prevented direct line-of-sight observation by the instrument.



A Prismlike End Fitting Bends the Viewing Angle so that a pyrometer can "look" at an object off its axis. The angled face directs thermal radiation from the object into the optical-fiber cable along its axis.

The pyrometer will be fitted at its sensing tip with a sapphire cylinder that has a slanted end face (see figure). The sapphire withstands the high temperatures of turbopumps. By refraction, the slanted face will bend the viewing angle away from the centerline of the optical fibers. (A 31° bend is the maximum possible; beyond this viewing angle, total internal reflection would occur, and it would be necessary to resort to a more-complicated prism shape.)

This work was done by Lynn M. Wyett and Michael R. Randall of Rockwell International Corp. for **Marshall Space Flight Center**. *No further documentation is available.*
MFS-29283/TN

FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*
REFER TO THE NUMBER LISTED AT THE END OF THIS ARTICLE

NASA Tech Brief
National Aeronautics and Space Administration
Lyndon B. Johnson Space Center, Houston, Texas

Control Algorithms for Liquid-Cooled Garments

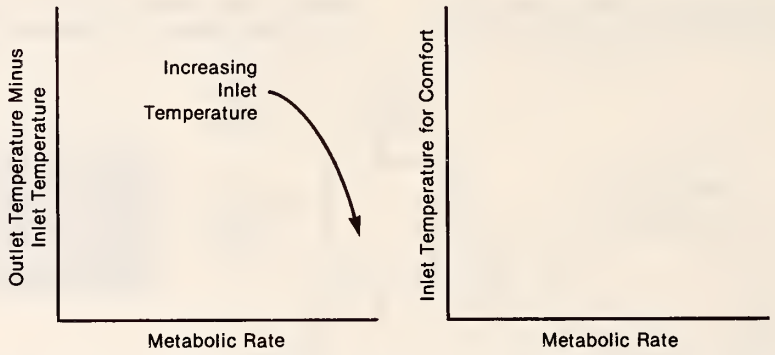
Three schemes control the transfer of heat to and from the wearer's body.

Three algorithms have been developed for the control of cooling in protective garments. Although the algorithms are directly applicable to space suits, they can also be used for automatic control of cooling in suits worn by workers in radioactive, polluted, or otherwise hazardous environments. The algorithms are expected to be more effective than manual control, which is subject to frequent, overcompensated adjustments as the level of activity varies.

All three algorithms follow a comfort curve of inlet-liquid temperature versus metabolic rate based on tests of human subjects. The first algorithm controls the average of the inlet and outlet temperatures of a water-cooled garment. It eliminates the effects of heat from the environment in the sense that it reduces the inlet temperature to compensate for the increase in the outlet temperature caused by the surroundings. If the environment is cold, the algorithm compensates for heat lost to it by raising the inlet temperature.

The algorithm is designed for a maximum metabolic rate of 1,300 Btu/h (380 W). At this rate, the wearer's body produces a rise of only about 2 °F (1 °C) in the temperature of the coolant. The average temperature of the coolant is therefore almost the same as the effective temperature felt at the skin.

The second algorithm adjusts the inlet temperature to follow the comfort curve. While this algorithm does not compensate for environmental heat loads, it is similar to the first algorithm in other respects.



The Metabolic Rate Is Inferred from the temperatures of the cooling liquid at the outlet and the inlet, suitably filtered to account for the thermal lag of the human body. The temperature at the inlet is then adjusted to the value that gives maximum comfort at the inferred metabolic rate.

Both the first and the second algorithms use the metabolic rate as a control variable. The rate is determined from a respiratory measurement — either the consumption of oxygen or the production of carbon dioxide.

The third algorithm is based in part on the empirically determined proportionality between the steady-state rate of metabolism and the difference between the inlet and outlet temperatures. This algorithm raises or lowers the inlet temperature according to the inferred metabolic rate (see figure). It compensates for the environmental heat load indirectly by interpreting the environmental component of the inlet-to-outlet temperature rise as being caused by metabolic heat load.

All of the algorithms incorporate delays in the form of thermal time constants characteristic of human bodies (about 15 to 20 min). The delays take into account the tendency of the human body to store heat instead of heating up immediately when it suddenly increases its level of activity. The delay prevents overcooling while the body is storing heat as it starts a higher level of activity and prevents overheating while the body dissipates stored heat as it starts a period of reduced activity.

This work was done by B. Drew, K. Harner, E. Hodgson, J. Homa, D. Jennings, and J. Yanosy of United Technologies Corp. for **Johnson Space Center**.

MSC-21349/TN

FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*
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NASA Tech Brief
National Aeronautics and Space Administration
Marshall Space Flight Center, Alabama

Numerical Modeling of Two-Phase, Reactive Flows

Capabilities of several computational schemes are combined and enhanced.

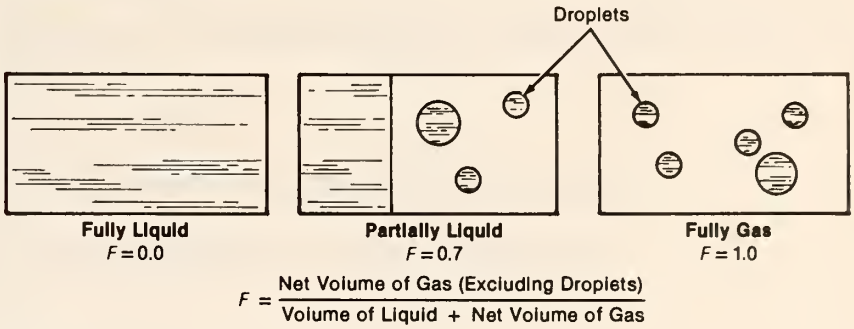
The Advanced Rocket Injector-Combustor Code (ARICC) is a computer program for the numerical simulation of two-phase flows of chemically reacting or nonreacting components. It can be applied to sprays of fuel in injectors and combustors; flows in heat exchangers, evaporators, and mass-diffusion systems; and two-dimensional or axisymmetric flows containing liquid or solid suspensions (e.g., coal slurries flowing in pipes).

Specialized computer codes had previously been developed, each to solve a specific type of fluid-dynamic problem, but no single code could treat all of the phenomena encountered in liquid/gas interactions. The capability of ARICC for the comprehensive modeling of many of these phenomena is due to the combination of the capabilities of several of the previous codes, including the following:

- The implicit-continuous-Eulerian (ICE) scheme and arbitrary-Lagrangian/Eulerian-Mesh treatment for all flow speeds from the CONCHAS-SPRAY code for reactive flows with fuel sprays;
- The equilibrium- and kinetic-chemistry models from CONCHAS-SPRAY;
- The fractional-volume-of-fluid technique from the SOLA-VOF algorithm for transient fluid flow (see figure); and
- The model for atomization from a program for the coaxial-injection combustion mode (CICM).

In addition, ARICC incorporates a new finite-droplet-displacement-volume description.

The resulting program is a two-dimensional (or axisymmetric with swirl) code for real-time transient flows. Unlimited numbers of chemical species and of kinetic (slow) or equilibrium (fast) chemical reactions can be included. Discrete droplets of any size, with individual identities and properties, are described by use of the Monte Carlo numerical group technique and tracked in a Lagrangian fashion.


Droplets
Fully Liquid
F = 0.0
Partially Liquid
F = 0.7
Fully Gas
F = 1.0
F = Net Volume of Gas (Excluding Droplets) / Volume of Liquid + Net Volume of Gas
Features:
• Droplets may exist in cells with F > 0.0.
• Single-valued thermodynamic properties are used in all cells.
• Pressure in fully liquid cells is determined by a pressure-iteration scheme for incompressible fluids.

Active Cells in the finite-difference computational grid are distinguished by their values of the flag variable, *F*.

Cells that are inactive or that are fully liquid, partially liquid, or fully gaseous are distinguished from each other by a cell-flag/volume-of-fluid variable *F* (see figure). Gaseous portions of the cells satisfy the perfect-gas equation and are subjected to the normal ICE pressure-iteration technique for compressible flows (similar to the successive-overrelaxation scheme) to achieve convergence in satisfying the Navier-Stokes equations.

Liquid portions of the cells are given a constant temperature and density and go through an iteration scheme that enforces the conservation of volume. The portion of the liquid in each cell that contains a gas/liquid interface is periodically converted into droplets, according to the model for atomization, which calculates the mass-stripping rate and the mean drop radius as functions of the local conditions.

Droplets are then numerically diffused, convected, heated up, and evaporated according to empirical models. The dynamics of the droplets are fully coupled with the conditions of the fluid in each cell. Droplets, the paths of which lead them toward liquid surfaces, are "recondensed" back into the liquid. Chemical reactions and turbulent mixing take place only in the gaseous phase.

ARICC can be used in research for the development and verification of various physical models. In particular, models of atomization and of the breakup, coagulation, and deformation of droplets can be studied with rigorous description of the fluid-dynamic environment. Such mechanisms as the propagation, holding, and instabilities of flames and kinetic-chemistry models are also particularly suited for study with ARICC.

This work was done by Pak-Yan Liang of Rockwell international Corp. for **Marshall Space Flight Center.** *MFS-29027/TN*

FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*
REFER TO THE NUMBER LISTED AT THE END OF THIS ARTICLE

Environmental Science & Technology

0463 Analytical Techniques for Measuring the Effects of Acid Deposition on Coatings on Wood

0464 Evaluation of Hydrologic Models in the Design of Stable Landfill Covers

Testing & Instrumentation

0465 New Materials Can Help Gauge Coal Sulfur Content

0466 How to Detect Leaks in Underground Storage Tanks

United States
Environmental Protection
Agency

Atmospheric Research and
Exposure Assessment Laboratory
Research Triangle Park NC 27711

Research and Development

EPA

Project Summary

Analytical Techniques for Measuring the Effects of Acid Deposition on Coatings on Wood

Preliminary experiments have been carried out to characterize the potential deleterious effects of acidic deposition on three representative paints: an oil alkyd paint and two acrylic latex formulations. The base polymer latex common to both latex paints was also studied individually. Free films of paint have been exposed to relatively high levels of gaseous SO_2 and ultraviolet light, and have been immersed in aqueous SO_2 at pH 2.0. Several analytical techniques have been used to assess the resulting chemical and physical changes in the paint films, including sorption and diffusion measurements, attenuated total reflectance infrared spectroscopy, dynamic mechanical analysis, sol-gel analysis, contact angle measurements, differential scanning calorimetry, and electron spin resonance. All techniques show promise for characterizing the early stages of damage to paint films caused by acidic deposition. The major effects noted in this study include leaching of acid-soluble extender components upon immersion in aqueous SO_2, and enhanced degradation of the base polymer upon exposure to gaseous SO_2 and ultraviolet light.

This Project Summary was developed by EPA's Atmospheric Research and Exposure Assessment Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The objectives of this project are: (1) to study the effects of acid deposition products in combination with near-uv radiation of the micro- and macro-structures of acrylic latex paint coatings, (2) to assess microdamages experienced by acrylic copolymers upon exposure to acid deposition; (3) to determine mechanistic paths that lead to polymer structural changes and microdamage; and, (4) to relate molecular structural changes to macrodamages that affect the service life of exterior coatings used on wood substrates.

The following analytical techniques will be employed: Intrinsic viscosity; Sol/Gel Analyses; Gel Permeation Chromatography; Surface Contact Angles; Differential Scanning Calorimetry (DSC); Dynamic Mechanical Analysis (DMA); Stress-Strain Analysis; Fatigue Tests; Infrared Spectroscopy; Electron Spin Resonance Spectroscopy; ESCA and SIMS; SEM - Fracture Surfaces studies. Changes will be followed in molecular weight, molecular weight distribution, glass transition temperature, changes in bulk properties, the amount of polymer chain scission, crosslinking and oxidation upon exposure of the paint coatings to ultra-violet radiation, SO_2, NO_x and mixtures of the SO_2 and NO_x with air and/or water.

The resulting data will permit determination of the mechanistic paths that result in the degradation of the base polymer in the paint coating and allow the prediction of useful lifetimes of coatings exposed to acid rain pollutants.

Experimental Procedures

Films of the base and compounded latexes were prepared by the drawdown procedure, using standard draw-down bars, on release paper. They were dried at R.T. for 4 hr, stored in a desiccator oven drierite for 48 hr and then heated at 40°C for 48 hr under vacuum. The films prepared in this manner absorbed negligible amounts of water when stored at R.T. and 64% R.H.

A sample of each film before and after exposure to various environments was obtained and placed in tetrahydrofuran (THF) for 3 days. The soluble portion was separated from the insoluble portion by filtration, the insoluble portion dried and weighed to determine the gel content. The amount of sol was determined by evaporation of the THF.

Intrinsic viscosities were determined at 25°C using modified Cannon-Fenske viscometers.

Thermal analyses were performed with either a Perkin-Elmer DSC-2 or -7,

each equipped with a data station.

Samples 1 cm by 6 cm were cut from each film using care to obtain uniform widths. The thicknesses were measured with a micrometer. Dynamic mechanical analyses (DMA) tests were made with an Autovibron DDV-II-C at a frequency of 11 hz and a scanning rate of 2.5°C/min.

The films were exposed to uv light (254 or 350nm) in a Rayonnet U.V. reactor. The samples were mounted in quartz tubes equipped with inlet tubes for SO_2, NO_x, air or various combinations.

Contact angles were measured with an NRL goniometer using distilled water.

The solubility/diffusivity data for gases in polymers is obtained using conventional weight-gain techniques. A sensitive electrobalance system enclosed in a vacuum chamber was constructed for this purpose. Provisions are made for maintaining constant diffusant pressure and temperature. Mass changes (as small as a few micrograms) are monitored as a function of time, and continuously displayed on a chart recorder. A second electrobalance system that can be used in corrosive environments, to be built in the second year, will greatly speed up the data collection process. An Analect FX-6260 FTIR spectrometer equipped with an MCT detector and a flat-plate ATR sampling accessory was used to obtain the infrared spectra. A ZnSe parallelogram crystal with an angle of incidence of 45° was used. All ATR spectra were collected at $4cm^{-1}$ resolution, and 128 scans were accumulated for each sample. The paint films for FTIR Analysis were cast on a clean glass plate surface, dried overnight in air, and transferred to a desiccator containing anhydrous $CaSO_4$ for a minimum of three days. Film thickness was measured using a sensitive micrometer having a precision of ±1.2 μm. The thickness of the films used in this study was 127 μm (about 5 mils).

A coating device for putting a thin, uniform film of paint on a cylindrical ATR crystal was constructed for FTIR analysis of diffusion kinetics and in-situ analysis of chemical reactions. The associated gas delivery system for these experiments has also been completed. The system will be tested, and should be operational by July 1988.

Preliminary Solubility and Diffusivity Data for SO_2

Sorption isotherms at 28°C for SO_2 in the Latex without $CaCO_3$ (LO), Latex with $CaCO_3$ (LC) and polyer base samples have been obtained. The solubility of SO_2 in the samples varies linearly with pressure up to 650 torr (Henry's law behavior) for the two paint samples and the polymer base. The paint sample containing $CaCO_3$ superimposes on the base polymer isotherm, while the sample without $CaCO_3$ has a slightly higher slope. This difference could be due to an inconsistency in the reported amount of polymer in this paint; a value of 35% was used to normalize the data for both paint samples to grams polymer. Reproducibility tests are in progress to check this.

Diffusion coefficients (D) were obtained for SO_2 In each sample at each experimental pressure. D was found to increase with increasing pressure. This trend has been observed before for SO_2 In a polyimide.This is attributed to plasticization of the polymer by the penetrant. The increase in D is most pronounced for the paint sample without $CaCO_3$.

The total flux of SO_2 through these samples is proportional to the permeability, P, which is equal to the product of the diffusivity D and the solubility k_D (Henry's law constant). The pressure-dependent diffusivity translates to a pressure-dependent permeability. The permeabilities of the polymer base and the $CaCO_3$-containing paint are again very comparable, and are in the neighborhood of 10^{-7} cc(STP) cm^2/cm^3 polymer-torr-sec. The permeabilities of the $CaCO_3$-free paint are an order of magnitude higher.

Summary

During the first year of this project, preliminary studies were conducted to determine the best techniques to identify chemical and physical effects on polymeric coatings used on wood due to wet and dry acid deposition. The following techniques were employed: Fourier transform IR, gravimetric measurements to obtain diffusivities and solubilities, dynamic mechanical analysis (DMA), sol-gel analyses, intrinsic viscosities (IV), differential scanning calorimetry (DSC), contact angle and electron spin resonance (ESR). Emphasis during the initial phase of our investigations has been on free films of latex paint. Some preliminary work has begun on alkyd paint films and coatings on wood substrates.

Preliminary exposure studies show that the techniques employed are well suited to follow changes in the microstructure of latex films as a function of exposure to acid deposition.

C.M. Balik, R.R. Fornes and R.D. Gilbert are with NCSU, Raliegh, NC 27695. J.W. Spence Is the EPA Project Officer (see below). The complete report, entitled "Analytical Techniques for Measuring the Effects of Acid Depositlon on Coatings on Wood,"(Order No. PB 89-127 518/AS; Cost:$15.95, subject to change) will be available only from: NTIS, 5285 Port Royal Road, Springfield, VA 22161;703-487-4650. The EPA Project Officer can be contacted at: Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protectlon Agency, Research Triangle Park, NC 27711.

United States
Environmental Protection
Agency

Risk Reduction
Engineering Laboratory
Cincinnati OH 45268

Research and Development

EPA

Project Summary

Evaluation of Hydrologic Models in the Design of Stable Landfill Covers

Federal regulations stipulate that landfill cover technology ensure the long-term stability and integrity of a hazardous waste landfill system. Specific guidance for achieving compliance with these regulations requires cover designs that manage the water balance on the landfill site. Special attention must be given to the design of the soil profile and the establishment of a stable vegetative cover in order to minimize erosion of the surface soils and the percolation of water into the waste. Recommendations for a specific landfill must be based on a combination of field and laboratory data, and computer modeling of water balance to assess specific design scenarios. The purpose of this study was to investigate the utility of two hydrologic models (CREAMS and HELP) for assisting in the process of designing landfill cover systems that are stable and free of maintenance requirements.

The process of parameterizing and using simple hydrologic models is outlined. Examples of modeling potential and actual sites are presented. Results of the modeling study suggest that, overall, CREAMS performs more satisfactorily than HELP in accurately predicting the soil water storage in the soil profile although more detailed calibration of HELP will probably improve model performance. While relative estimates of runoff, deep percolation and evapotranspiration are very useful for comparing different cover designs, absolute quantitative estimates of these values are subject to considerable error. Choice of values for soil parameters requires more experience and more detailed data than is indicated by the documentation for either model. Data to support choice of vegetation parameter values are largely unobtainable, especially for the native plant species which will inevitably invade a landfill site. Successional processes that lead to such invasions are discussed, and it is concluded that establishment of a vegetative community consisting of a mix of native plant species would result in a vegetative cover that is the most stable and most efficient in removing water from the soil profile.

This Project Summary was developed by EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of the research projects that are fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Landfill systems for the long-term containment of hazardous or municipal waste will be an essential component of hazardous waste management for the foreseeable future. Even under regulatory requirements for incinerating or degrading waste material in order to reduce the toxicity of the waste, the remaining sludges or residues must be disposed of or stored in such a manner as to protect the environment from toxic interactions. Certain hazardous wastes will probably continue to be buried in landfills. In addition, a large number of older waste sites are in urgent need of closure technology to prevent further damage to the surrounding environment.

Major factors contributing to the mobilization of toxic constituents in wastes and their subsequent release to the biosphere include the infiltration of surface water, percolation of ground water into the waste, and intrusion into the waste by plants or animals. A critical determinant of the long-term successful application of land disposal technology is the stability of the cap or cover of the disposal unit. If, through a variety of potential mechanisms such as erosion, plant and animal disturbances, settling and other mechanical disturbances, the critical functions of the cover are compromised, then the long-term performance is compromised as well.

Establishment of a suitable and long-lasting plant cover is the critical factor for minimizing erosion of the surface soils of the cover system and also for the management of the water balance of the entire cover system. The understanding of the water balance components at a

site is essential for the design of a cover system as well as for other remedial measures. The soil which can act as reservoir for water, or as a conduit for subsurface transport of infiltrating water, also supports the vegetative layer as a mechanical base and is a reservoir for water and nutrients. The water use and rooting characteristics of the vegetation can determine the extent of percolation of water below the rooting zone as much or more than soil hydrologic properties. Thus, an estimate of the effects of different soil and vegetation combinations on the water balance of a cover system must be an integral part of land disposal design process.

The purpose of the project was to investigate the utility of the hydrologic models HELP (*Hydrologic Evaluation of Landfill Performance*) and CREAMS (*A Field Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems*) for assisting the process of designing landfill cover systems that are stable over long periods of time and have no maintenance requirements in the period after 30 years post-closure. The report discusses concepts of low maintenance and stability for soil/vegetation systems. The utility of these models was explored through studies of the parameters for the design of land disposal units at several sites, assuming a variety of regionally possible plant covers, and in an assessment of the performance of the models in simulating experimental landfill cover systems under a variety of controlled field conditions of vegetative cover.

Simulation of Field Experiment

Simulations of the different scenarios were made using the CREAMS and HELP models. Parameter values for soil hydrologic characteristics were optimized using data for a shrub plot for which there was a four-year record of soil moisture (two years prior to the start of the experiment plus two years during this study). Optimization was performed by varying values within recommended ranges for hydraulic conductivity, field capacity, wilting point and curve number and then performing a linear regression analysis between observed and predicted soil moisture over a three-year period. The process was repeated until it was apparent which combination of parameter values resulted in the highest correlation coefficient (indicating the least amount of scatter in values), the slope of the regression line closest to 1.0 (indicating a dynamic range in predicted values that most closely approximates the variability observed in the field) and an intercept closest to 0.0 (indicating an absolute value of soil moisture values most closely resembling the observed values).

Although CREAMS more accurately predicted field observations than the HELP model, CREAMS still should be used with several precautions. Actual values for soil hydrologic parameters will undoubtedly produce better results than values assumed on the basis of soil texture class. However, actual values for the soils to be used on the landfill will, in all probability, not be readily available. A reasonable effort to develop values for soil parameters through laboratory tests would greatly increase the accuracy of the model.

Conclusions

The results of this study have demonstrated unequivocally that the role of native vegetation in determining site stability and integrity must be evaluated and considered in designing a hazardous waste landfill cover system. It is apparent that native species are much hardier than cultivated species. Given a long enough period of time with no human interference (i.e. no maintenance) native species will invade and colonize a landfill site, and some sequence of succession will proceed thereafter. Unfortunately, these processes are not well documented, especially for severely disturbed sites or on constructed soil profiles.

The use of simple hydrologic models to simulate the water balance of landfill cover systems can assist the process of designing soil and vegetative systems for site closure. Two models (CREAMS and HELP) were used to simulate eight experimental cover designs on a landfill site at Los Alamos, New Mexico. Results of the modeling study suggest that, overall, CREAMS performs more satisfactorily than HELP in accurately predicting soil water storage in the soil profile, although more detailed calibration of HELP will probably improve model performance. Careful parameterization of the models was a key to successful simulation. Few data exist for leaf area indices and rooting depths of native plant species. Values of hydrologic parameters of soils may be quite different in the constructed soil profiles of landfill covers than under laboratory or natural conditions. These areas are in critical need of further research.

Fairley J. Barnes and John C. Rodgers are with the Los Alamos National Laboratory, Los Alamos, NM 87545.
Naomi P. Barkley is the EPA Project Officer (see below).
The complete report, entitled "Evaluation of Hydrologic Models in the Design of Stable Landfill Covers," (Order No. PB 88-243 811/AS; Cost: $21.95, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
Risk Reduction Engineering Laboratory
U.S. Environmental Protection Agency
Cincinnati, OH 45268

NIST Technology Update

National Institute of Standards & Technology
(Formerly the National Bureau of Standards)
U.S. Department of Commerce, Gaithersburg, MD 20899

New Materials Can Help Gauge Coal Sulfur Content

Because sulfur emissions from coal-fired industrial plants are regulated by environmental agencies, it is important for coal and utility companies to know how much sulfur is contained in a given coal batch. Likewise, coal companies and their customers need accurate determinations of sulfur and ash content along with calorific value to set fair tonnage prices of coal shipments. A new NIST standard reference material (SRM) can help boost the accuracy of all these measurements by allowing evaluation of laboratory methods and calibration of instruments used in coal analysis. The SRM, which consists of a 50-gram bottle of bituminous coal, is certified for its sulfur and ash content as well as its calorific value. Also included are non-certified value of 23 other elements.

FOR ADDITIONAL INFORMATION: The new material (SRM 2692) costs $102 and is available for the Office of Standard Reference Materials, NIST, B311 Chemistry Bldg., Gaithersburg, Md. 20899; telephone: (301)975-6776.

NAVY
Domestic Technology Transfer Fact Sheet

How to Detect Leaks in Underground Storage Tanks

Leaks in underground storage tanks may go unnoticed unless tanks are regularly tested or monitored for product loss. Because of the growing concern over the quality of the ground water, the Environmental Protection Agency has issued, and will be issuing in the future, regulations pertaining to the testing of underground storage tank systems. Naval Energy and Environmental Support Activity (NEESA) has developed *Leak Detection in Underground Storage Tanks* (NEESA 7-024A) to assist engineering field division and public works personnel in evaluating and selecting appropriate leak detection methods for underground storage tanks.

This guide discusses commercially available leak-detection equipment and the many environmental and equipment variables that can reduce the equipment's accuracy. For each model of leak detection equipment evaluated, the discussion includes the manufacturer's description of the method, the manner in which the equipment compensates for variables, and independent engineering comments.

This guide also provides information on underground storage tank laws and regulations, typical underground storage tank leak causes and locations, and inventory control. Appendices provide Navy and state underground storage tank contacts, as well as equipment manufacturer addresses. (From *Energy and Environmental News*, Naval Energy and Environmental Support Activity, Port Hueneme, California.)

For Additional Information:

Backup material on this effort is available from:

Navy Domestic Technology Fact Sheet Reader Reply Service
Code E211
Naval Surface Weapons Center
Dahlgren, VA 22448-5000
(703) 663-8921

Refer to 131005/TN

Manufacturing, Machinery & Tools

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U.S. Army Fact Sheet

U.S. Army Industrial Engineering Activity, Rock Island, IL 61299-7260

Braiding Process for Composite Cannon Bore Evacuator

Watervliet Arsenal has developed an interesting braiding process for composite material. The system used for demonstrating the process was the evacuator for the 120 mm M256 cannon on the Abrams tank. Evacuators are cylindrical sleeves placed over the outside of cannon tubes to form pressure chambers for removing hot gases remaining in the tube after firing.

The new process was developed with a braiding machine that applies helical filament wraps and longitudinal fibers to a collapsible and removable metal evacuator mandrel. The machine is controlled by a robot and incorporates an applicator ring which impregnates the fibers with resin just before they are applied to the mandrel.

The new braiding process produces evacuators with improved damage tolerance properties and lower layup time compared to the current filament winding approach. Although it requires two hours of setup time for every hour of operation (vs. minutes for the current machines), two braiding machines (which cost less than one current machine) can easily compensate for this. Implementation of the braiding process on the 120 mm cannon and other possible applications is being pursued.

FOR ADDITIONAL INFORMATION: Additional information can be obtained by contacting Mr. F. Anderson, AMXIB-PA, Production Engineering Division, U.S. Army Industrial Engineering Activity, Rock Island, Il 61299-7260, AUTOVON 793-7801 or Commercial (309)782-7801.

U.S. Army Fact Sheet

U.S. Army Industrial Engineering Activity, Rock Island, IL 61299-7260

Composite Drive Shafts

A mass production process for producing organic composite drive shafts for use on military vehicles has been developed recently for the U.S. Army Tank-Automotive Command. The demonstration vehicle for the drive shaft is the High Mobility Multi-purpose Wheeled Vehicle (HMMWV). This was chosen because the current two-piece steel shaft, coupled with a universal bearing, was experiencing failure at high vehicle speeds. The light weight and high modulus of organic composite materials allowed the design of a single piece shaft.

Special samples were fabricated, statically and dynamically tested and then field tested. Results showed that organic composite shafts met all specifications, reduced weight by 70%, reduced life cycle cost, improved corrosion resistance and reduced maintenance.

FOR ADDITIONAL INFORMATION: Additional information can be obtained by contacting Mr. F. Anderson, AMXIB-PA, Production Engineering Division, U.S. Army Industrial Engineering Activity, Rock Island, IL 61299-7260, AUTOVON 793-7801 or Commercial (309) 782-7801.

Department of Defense Fact Sheet

Concurrent Engineering Concept is Practiced by the Army as Producibility Engineering

WHAT IS CONCURRENT ENGINEERING?

Concurrent Engineering is a systematic approach to creating a product design that considers all elements of the product life cycle from conception to disposal. In so doing it simultaneously defines the product, its manufacturing process and any other life cycle processes, such as maintenance.

The underlying concept of concurrent engineering is not high technology, but rather "back to basics". Sometimes this approach is referred to as Simultaneous or Integrated Engineering. The concept described here has been a formal part of Army acquisition since the early 1980s.

PHILOSOPHY OF CONCURRENT ENGINEERING

The philosophy of concurrent or simultaneous engineering encourages the use of a multi-disciplinary team early in the design phase of a system's life cycle. The idea is to insure the consideration of such characteristics as producibility, maintainability, and reliability at a time when the cost of implementation is relatively low. By designating the processes for production simultaneously with the design, there are fewer "surprises" during manufacturing and a higher probability of meeting the originally projected schedule for delivery.

NOT TRULY SIMULTANEOUS

The process is not truly simultaneous. The design for performance/design for production cycle is reduced to a series of interactive interchanges over short periods of time. This is instead of what traditionally has been a full cycle of design for performance followed sequentially by consideration of how to manufacture that design.

EVOLVING IMPLEMENTATION

The process of developing the expertise and the appropriate contractual instruments with which to implement the concurrent engineering concept have continually evolved. Guidance and regulation have been developed and incorporated from every level of the Department of Defense.

REGULATION GUIDANCE

AMC Regulation 70-6 covering Producibility Engineering and Planning (see page 4) is being updated and republished to reflect, among other things, the experience gained in concurrent engineering. DoD 4245.7-M, "Transition from Development to Production", also known as "The Templates", has served as the basis for insuring concurrent engineering by requiring the design team to plan for the downstream requirements of production, maintenance and logistics support. The Navy's "Best Practices" manual illustrates some of the traps that await Program Managers who do not establish multi-disciplinary concurrent engineering teams early in the design phase.

INTENT OF REGULATIONS

The intent of these regulations and guidelines is to establish the requirement for up front consideration of the downstream characteristics which frequently become heavy cost drivers and schedule extenders when they require redesign. By making concurrent engineering an integral part of the Acquisition Strategy and the Request for Proposal, rather than a "Special Program", the development effort will evolve products which meet all the requirements and transition to production with minimum difficulty.

COST SAVINGS

Cost savings from concurrent engineering are expected to accrue on a total life cycle cost basis. Lowered costs are expected to result from less capital investment for production and maintenance, lower start up and full scale production costs, and lower Operation and Support costs due to the higher reliability and superior quality of production hardware.

SOME COSTS INCREASE

However, Demonstration Validation and Full Scale Development costs may actually increase because costs for producibility engineering and planning, process development, and proof of production may not be offset by reduced prototyping and test savings. Projection of these savings will, at best, be empirical and difficult to defend.

PRINCIPAL JUSTIFICATION

The principal justification for employment of concurrent engineering/producibility engineering and planning comes from the costly experience of producing and fielding immature designs. The emphasis is now directed towards maturing the design and process before production. Not withstanding the above, methodologies used to determine savings publicized by others will be studied for potential use by the Army.

IMPACT ON ACQUISITION

The concurrent engineering methods and practices which can make a significant impact on the DoD acquisition process include:

- Early understanding and documentation of the user's requirements and priorities.
- Near simultaneous translation of those requirements into both product and processes for manufacture.
- Optimization of product and process characteristics in the trade off against performance and cost.
- Verification and validation of decisions made during design.
- Utilization of a combined functional team with a "hands on" approach to the design of product and processes.

SUMMARY

- Army practices the concept of Concurrent Engineering.
- Army program has been in effect and is implemented.
- Significant policy, regulations and guidance are in use.
- On-going acquisitions preclude the need for Pilot Programs.
- Army accepts the term Concurrent Engineering to describe its complete Producibility Engineering and Production Planning Program.
- The concept was pioneered by the Army and the leading industrial base contractors as "integrated engineering."

MORE INFORMATION

Contact Mr. Steve Balint, AUTOVON 284-6209 or Commercial (202) 274-6209 if there are any questions about concurrent engineering.

U.S. Army Fact Sheet

U.S. Army Industrial Engineering Activity, Rock Island, IL 61299-7260

Composite Rotor Blades

A special composite main rotor blade has been developed for the U.S. Army Aviation Systems Command for the Blackhawk Helicopter. It will replace the current titanium spar composite blade. The final approach selected for production was to precure the graphite/Kevlar epoxy composite spar. This lowered manufacturing risks by providing precise spar weight and balance control, allowing improved non-destructive inspection, and permitting the use of current production tooling.

The advantages of the new composite rotor blade are increased reliability, increased service life of the blade cuff, increased ballistic survivability and reduced manufacturing costs. Material and labor costs are lowered by 21% and 26%, respectively.

FOR ADDITIONAL INFORMATION: Additional information can be obtained by contacting Mr. F. Anderson, AMXIB-PA, Production Engineering Division, U.S. Army Industrial Engineering Activity, Rock Island, IL 61299-7260, AUTOVON 793-7801 or Commercial (309) 782-7801.

Navy Manufacturing Technology

Automated Manufacturing Research Facility

National Institute of Standards & Technology
Formerly the National Bureau of Standards (NBS)
U.S. Department of Commerce, Gaithersburg, MD 20899

Investment Analysis Software for Automated Manufacturing

Current methods for justifying investments in automated manufacturing equipment generally use narrow financial criteria. Factors which may affect the competitive position of a company such as throughput, lead time, production quality, and flexibility are not included.

The NIST Center for Computing and Applied Mathematics (CCAM), working under sponsorship of the AMRF, has developed AutoMan, a software package which allows investors to include non-financial and even non-quantitative criteria in their analysis. AutoMan was developed with MANTECH support and currently is being beta-tested by forty-eight companies.

AutoMan uses four steps to measure the impact of potential investments: define the decision model by indentifying impact criteria; establish weights for the categories and for the criteria through pairwise comparisons; rate investment alternatives with respect to each criterion; and compute a weighted average rating for each investment alternative.

Several "starter" decision models which specify categories and criteria as examples are included with AutoMan. The user can easily apply these models or develop new ones with up to seven categories of impacts and up to seven criteria per category. The forty-nine criteria may be either quantitative or qualitative. Models can be developed, revised, selected, and applied with ease.

NIST researchers developed AutoMan in collaboration with the AMRF, the U. S. Navy, and CAM-I (Computer Aided Manufacturing-International) a consortium of manufacturing firms.

For Additional Information:

To discuss this effort further, contact:
Dr. Stephen F. Weber
AMRF Project
Building 101—Room A-415
National Institute of Standards & Technology
Gaithersburg, MD 20899
(301) 975-6137

NAVY Manufacturing Technology Program

National Metalworking Technology Center

The National Center for Excellence in Metalworking Technology (NCEMT) was established in January 1988 as part of the Navy Manufacuring Technology Program to address Navy/DOD metalworking technology needs. NCEMT serves as a national resource for the development and dissemination of advanced metalworking technology and processes to improve the defense industrial base.

Operated by Metalworking Technology,Inc., a nonprofit subsidiary of the University of PittsburghTrust, in Johnstown, PA, NCEMT is the third national center for excellence established under the Navy MT Program. NCEMT's primary mission is to advance the state-of-the-art in metalworking technology and conduct effective technology transfer in metalworking processes.

Leading edge technologies, such as process modeling, expert systems, and state-of-the-art test equipment, are being emphasized to ensure that effective, long-term solutions to metalworking problems are addressed. NCEMT's focus is upon high risk/ high inpact metalworking problem areas involving both traditional and advanced materials, including net-shape forming processes and products, surface treatment and structural control, joining and cutting processes, process modeling and automation, and the technology of specialty materials.

Current NCEMT technical initiatives include:

- development of an advanced weld filler metal for joining high strength steel plates in the 100 ksi and 130 ksi classes
- an artificial intelligence expert system to increase the effectivness and control of a shipyard welding system
- improved production methods for alloy flasks used in submarine gas management systems
- a hybrid expert system and finite element modeling system for net-shape forming of beryllium parts by hot isostatic pressing
- development of a finite element methodology for simulation and prediction of manufacturing defects in welding, forming, and casting process.

NCEMT will develop solutions, transfer those solutions to the interested Navy activity and/or participating company, and provide training in the use of the technology when necessary to meet the technical objective. The mission and structure of NCEMT provide a unique opportunity for development of the strong government/industry/ university coupling needed for improved effectiveness of metalworking technology transfer.

For additional information, contact:
Dr. Howard A Kuhn
Technical Vice President
Metalworking Technology, Inc.
1450 Scalp Avenue
Johnstown, PA 15904
Telephone: (814) 266-2874

NAVY Manufacturing Technology Program

Porous Material Extends Life of Bearings

A key component of all ball bearings is the bearing retainer, i.e., the precision machined ring which contains the balls and maintains ball separation. In high speed applications, such as inertial gyro motor bearings, the bearing retainers are fabricated from materials which not only meet stingent mechanical requirements, but are also designed to hold and provide lubricant for the balls. The retainers for this purpose are typically fabricated from porous composite materials such as phenolic/cotton and phenolic/paper. Once assembled, the gyro motor bearings are sealed in an inert enviroment and run until failure occurs. Since, in some cases, bearing failures have been identified as causing greater than fifty-percent of system failures, efforts were undertaken by NAVAIR to make a new, porous, nonmetallic, single-base ingredient bearing retainer material available to the bearing industry. The successful results of this effort (MT project AO411) were demonstrated to industry and government representatives in April 1988.

The credit for this accomplishment belongs to the Naval Weapons Support Center, its contractor Singer-Kearfott, Little Falls, NJ, and their subcontractor, Dixon Corporation, Bristol, RI. The new material is a porous polyimide called Meldin 9000. The material was first developed by Dynatech Coporation in conjunction with a Charles Stark Draper Laboratory gyro improvement program sponspored by the Air Force. Laboratory-produced samples of the new material demonstrated a life of over 3,000 hours as compared to a life of only 300 hours or less for a traditional material. Severe difficulty was encountered, however, in transferring the manufacturing process from the laboratory to the production enviroment. Initial attempts at full-scale production resulted in a material with higher procurement cost and a durability no better than the materials it was intended to replace. Now, as a result of the NAVAIR-sponsored MT project, Dixon Corporation has produced retainer material that Singer-Kearfott has run for over 50,000 hours in two of its gyro motors.

The establishment and demonstration of the new material and process specifications has successfully transitioned this advanced polyimide bearing retainer material from the laboratory to a full-scale production availability. Better and more cost effective material and process controls have been established to improve the material properties (e.g., tensile strength, oil retention, and thermal stability), and lot-to-lot product consistency. The material is now available for anyone to order and use in appropriate applications.

For additional information, contact:
Commanding Officer
Naval Air Engineering Center
Attn: Jennifer Jarrett (Code 5313)
Lakehurst, NJ 08733-5100
Telephone: (201) 323-2174
AV 624-2174

NAVY Manufacturing Technology Program

Near-Net Shape Hip of Complex Titanium Parts

On 15 November 1988, the Applied Technology Branch of the Naval Air Systems Command and Grumman Aircraft Systems sponsored a government/industry end-of-contract briefing on the results of a project (number A0680) to reduce the cost of producing large, complex titanium aircraft parts. The briefing was held at the research facility of Crucible Materials Corporation in Pittsburgh, PA.

Titanium aerospace hardware has been costly to produce primarily because of its high buy-to-fly materials ratio. Due to limitations on producing near-net shape titanium configurations, parts have typically been machined from forgings. This process results in a materials utilization factor on the order of 10 percent or less; i.e., 90 pounds of chips must be machined away from a forging to produce a 10 pound part. To overcome these limitations, Grumman considered three alternative approaches: hot die forging to near-net shape; casting; and hot isostatic pressing (HIP) of pre-alloyed titanium powder.

It was found that the hot die forging process was incapable of competing cost-wise with even conventional machined forgings because of excessive die cost. Furthermore, hot die forging was only applicable to simple shapes of limited plan view area. Although it was found that titanium castings were cost-competitive, it was impossible to use cast parts without applying a casting factor of 1.33 to the design of the part. This increased the weight and size of the part beyond acceptable limits. The third alternative was the approach taken for the NAVAIR-sponsored MT project.

Building upon work performed during the mid-to late 1970's which demonstrated the production feasibility and flight-worthiness of a 1 1/2 pound HIP titanium part, this project established Crucibles's ceramic mold process as the only viable process capable of producing large near-net shape titanium parts with mechanical properties equal to or better than wrought titanium alloys. The process uses pre-alloyed titanium powders supplied by Nuclear Metals.

The three-phased project involved powder certification, design and processing of parts, structural component validation, and determination of costs and specification requirements. In the initial phase on powder certification, Ti-6A-6V-2Sn pre-alloyed powder produced by the plasma-rotating electrode process (PREP) was characterized for comparison with regular rotating electrode process (REP) powder produced for the previous work on HIP compaction of small parts. Test blocks were consolidated according to previously established practices, and mechanical and metallurgical properties were obtained to certify the quality and, in particular, the cleanliness of the powder. A total of three lots of Ti-6-6-2 powder (850 pounds) were evaluated in the course of the program to ensure quality and repeatability. The last two lots of powder were produced two years after the first lot and the cleanliness was determined to be consistent. This resulted in compacts with no inclusions and acceptable mechanical properties equivalent to or better

than plate and forgings.

As the program progressed and implementable part configurations were changed, it became necessary to switch from Ti-6-6-2 to Ti-6Al-4V pre-alloyed powder. Test blocks were obtained to certify these powders by means of mechanical property and powder cleanliness evaluations. Five lots of PREP powder were used to produce test blocks and parts in this program. These powder lots comprised over 1,000 pounds of PREP powder produced at different times over a period of six years, thereby proving that clean, high quality titanium powder can be consistently produced. It was also shown that the HIP pre-alloyed powder had equivalent or better static and dynamic properties than ingot metallurgy material. The compressive, shear and bearing properties met specification requirements, and the crack growth resistance and stress corrosion properties were better than those in forgings. In addition, HIP parts that were electron beam (EB) welded proved to be equivalent to EB welded plate and forgings in strength and resistance to fatique.

In the second phase of the program, which ran concurrently with the first phase, the redesign of an F-14A nacelle frame as an electron beam welded assembly was accomplished, and initial iterations on the HIP of the various complex components to near-net shapes commenced. These studies resulted in the time to design wax patterns being cut from 320 hours to 16 hours; the excess material to be removed was reduced from 0.156 inches to 0.050 inches, thereby making chemical milling more feasible as an alternative to the more expensive mechanical milling processes. The capability of the ceramic mold process to accommodate large parts from 30 to 88 pounds was demonstrated.

Because of the criticality of the F-14A nacelle frame, and other considerations which made that part impossible to implement, other parts were evaluated. These included the A-6 wing fold fittings and composite engine door fittings, and the F-14D composite overwing fairing pickup fitting. Efforts on these parts determined that time savings in the overall production of these kinds of near-net shape parts was possible if a modified iteration approach employing CADAM techniques for designing patterns was employed, and if Crucible bid the delivery of each part to finish -machined dimensions. The latter would save a great deal of liaison time between the customer and the part supplier.

In the final phase of the program, the F-14D composite overwing fairing pickup fitting was subjected to static, fatigue, and elevated temperature tests in which the component was tested to failure. This pickup fitting is the most critically loaded of the six fittings used in the composite component tested. A parallel test was run on another component in which the fitting was machined from wrought titanium ingot material. The HIP powder metal part's performance in the test was equivalent to that of the machined forging.

Throughout the program, cost evaluations were conducted comparing HIP powder metal costs with those of parts machined from plate or forgings. Cost savings of 25% to 40% were projected for most parts depending on the quantity, complexity, and amount of inspection required.

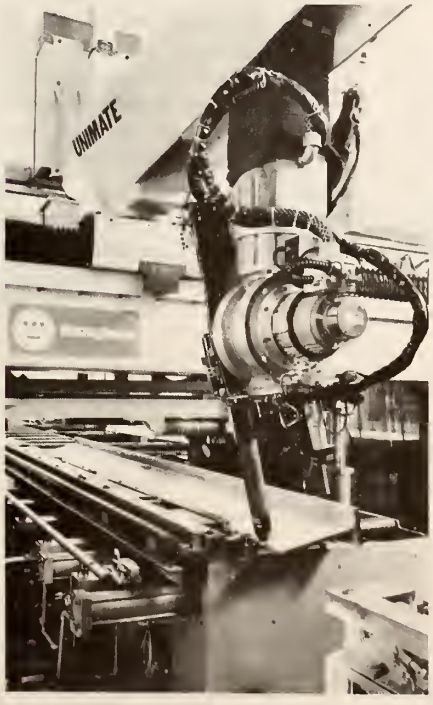
From the lessons learned on this program and the benefits derived, an economical approach to the production of near-net shape complex titanium parts is now available. The process is not only applicable to current titanium alloys but is also available as a prime process for rapidly solidified powder parts and titanium metal matrix composites.

For additional information, contact:
Commanding Officer
Naval Air Engineering Center
Attn: Greg Fisher (Code 5321)
Lakehurst, NJ 08733-5100
Telephone: (201) 323-2258
AV 624-2258

NAVY Manufacturing Technology Program

Programmable Robotic Shapes Processing System

Structural shapes, such as angle and tee bars, used in the shipbuilding industry, require a a wide variety of cutouts and end-cut configurations. The fabrication of these shapes is a highly labor-intensive operation characterized by the following manual operations: (1) marking of part identification and assembly information; (2) laying out of all cut configurations; and (3) cutting of the premarked configurations by means of hand-held oxyfuel torches for steel shapes and saws for aluminum shapes. These processing methods are time-consuming and can also result in added delays and costs due to inconsistent cut quality and dimensional accuracy.



PROGRAMMABLE ROBOTIC SHAPES PROCESSING SYSTEM

The Programmable Robotic Shapes Processing System (PROSHAPS) was demonstrated at Bath Iron Works Corporation in November 1988 by the Naval Sea Systems Command. It was designed and developed to provide increased efficiency, reliability and flexibility in structural shapes manufacturing. To achieve these objectives, PROSHAPS integrates computer systems, material handling equipment, robotics, and adaptive controls for automatic marking and plasma arc cutting of both steel and aluminum piece parts. PROSHAPS is comprised of two major subsystems, planning and production, each supported by a computer system which is linked via a local area network.

The planning system contains software modules, each with formatted screens, to perform the functions of piece part definition, production planning and control, and nesting. Once the automatic nesting routine is completed and verified, production jobs and execution instructions (e.g., robot commands) are transferred to the production computer system.

The production system, in conjunction with a DNC module, performs all production job scheduling, and work cell control/monitoring and feedback that occur subsequent to the planning process. All functions are invoked through the use of formatted screens which, like the planning system, are extremely easy to learn and operate.

The use of a flexible manufacturing

system, such as PROSHAPS, on the shop floor offers a number of benefits, among them:

- Reduced work-in-process inventory
- Shorter lead times
- Improved material utilization
- Improved dimensional accuracy
- Increased flexibility to respond to changes
- Reduced direct labor cost

For more information about PROSHAPS please contact:
Commander,
David W. Taylor Research Center
Attn: Mr. Robert L. Jenkins
Bethesda, MD 20084-5000
Telephone: (301)227-1363
287-1363

NASA Tech Brief
National Aeronautics and Space Administration
Marshall Space Flight Center Alabama

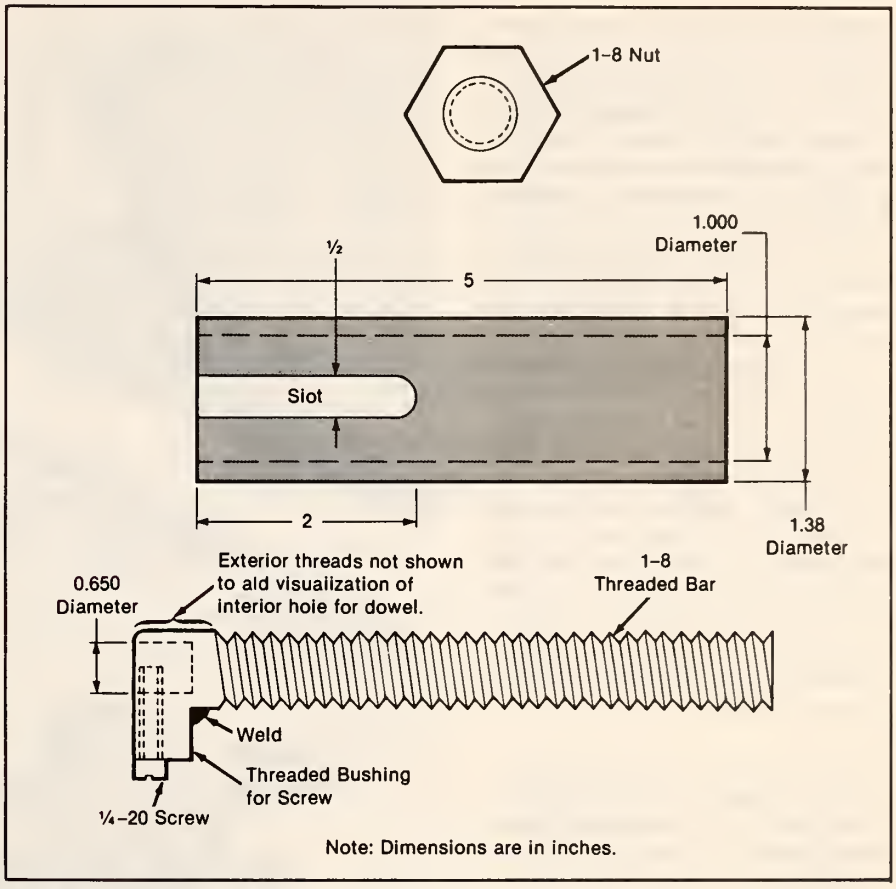
Dowel Remover

A tool extracts dowels quickly and safely.

A special tool pulls dowel pins straight out of blind holes. The tool removes the dowels without damaging them or possibly injuring the user, unlike tools like vise grips, pliers, channel locks, hammers, and chisels. It accepts the most common dowel sizes — ⅛- to ⅝-in. (3.2- to 15.9-mm) diameter.

The tool, which is simple and inexpensive, is made from a screw, a threaded bar, a slotted pipe, and a nut (see figure). A hole at one end of the threaded bar is positioned over the protruding end of the dowel, and a screw in the bar is tightened against the dowel. The slotted pipe is slipped over the bar with the slot engaging the threaded bushing that holds the screw. The nut is installed on the threaded bar and rotated so that it presses against the slotted pipe. Continued tightening of the nut pulls the threaded bar and, with it, the dowel.

This work was done by Jerry Blisse of Rockwell International Corp. for **Marshall Space Flight Center**. *No further documentation is available.*
MFS-29328/TN



Simple Parts Are Combined to pull a dowel out of its hole. The tool grips the dowel firmly. Even if the tool suddenly loses its grip on the dowel, it is unlikely to injure the user.

FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*
REFER TO THE NUMBER LISTED AT THE END OF THIS ARTICLE

NASA Tech Brief
National Aeronautics and Space Administration
Marshall Space Flight Center, Alabama

Licensing Opportunity

Grinding Parts for Automatic Welding

Rollers guide a grinding tool along the prospective welding path.

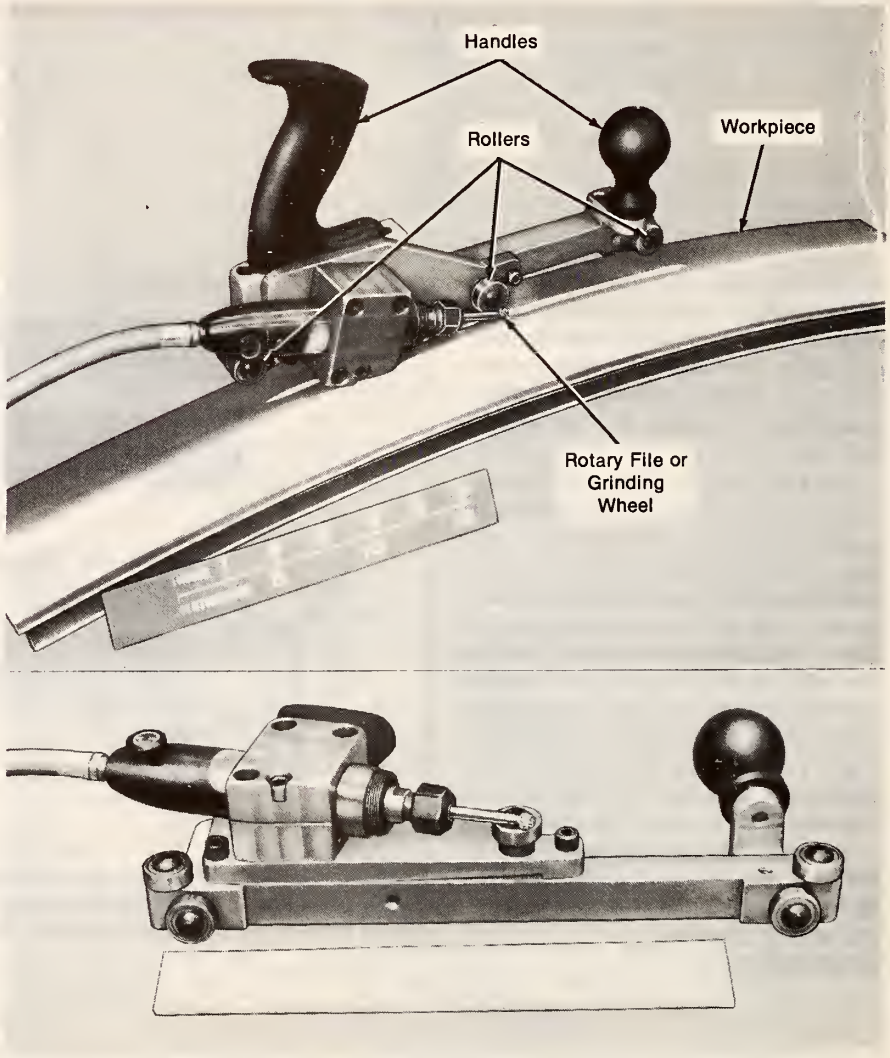
A skatelike fixture holds a rotary grinder or file for machining large-diameter rings or ring segments in preparation for welding. The fixture-mounted grinder machines the surface to a quality sufficient for automatic welding; manual welding with its attendant variations and distortion is not necessary. The fixture was developed to enable the automatic welding of parts, the manual welding of which had resulted in a weld bead permeated with microscopic fissures.

An operator moves the fixture around the circumference of the workpiece to be welded. As the fixture is moved, the air-driven rotary grinder removes material to a preset, adjustable depth.

The fixture moves on five rollers that maintain a fixed relationship with the workpiece, thereby ensuring precise machining (see figure). A pair of rollers guides the fixture around the periphery of the workpiece. Another pair rides on an edge to control the lateral position of the cutter. The fifth roller prevents the fixture from cocking.

This work was done by Richard K. Burley and William S. Hoult of Rockwell International Corp. for **Marshall Space Flight Center**. *No further documentation is available.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center Refer to MFS-29329/TN



The **Operator Grasps Handles** to push the rolling fixture along the part. Rollers maintain a precise dimensional relationship so that the grinding wheel can cut to a precise depth.

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FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*
REFER TO THE NUMBER LISTED AT THE END OF THIS ARTICLE

NASA Tech Brief
National Aeronautics and Space Administration
Lewis Research Center, Cleveland, Ohio

Fatigue Lives of Laser-Cut Metals

Fatigue lives can be made to approach those attainable by traditional grinding methods.

It has been demonstrated that the combination of the removal of metal by lasers with methodology for balancing via the use of influence coefficients holds promise as a new approach to precise balancing of components of gas-turbine engines. However, to qualify laser balancing for gas turbines, a comparison must be made between the fatigue lives of rotors machined by a conventional manual grinding technique and those machined by lasers.

To make this comparison, fatigue-test specimens were prepared from four metallic alloys; and material was removed from these specimens by manual grinding, by an Nd:glass laser, and by an Nd:YAG laser. The results of fatigue tests of all of the specimens indicated a reduction of fatigue strengths of the laser-fired specimens below those of the ground specimens. However, there was a lesser reduction of fatigue strength, particularly at lower numbers of cycles, in the case of the Nd:YAG laser.

Laser machining holds promise for improved balancing of components of gas turbines. The use of Nd:YAG lasers together with techniques for careful finishing of the burn zone offers potential for fatigue life comparable to that attainable with traditional grinding methods.

This work was done by Michael R. Martin of Mechanical Technology Inc. for **Lewis Research Center**. *No further documentation is available. LEW-14682 /TN*

FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*
REFER TO THE NUMBER LISTED AT THE END OF THIS ARTICLE

Materials

0479 Development of Magnesium Alloys for Aerospace Use

0480 Fracture Behavior of Al-Fe-X Alloys

0481 New Windshield to Improve Birdstrike Protection

0482 Stress Relaxation Behavior of 38664 Titanium Alloy

0483 Improvements in the Floating Roller Peel Test for Adhesives

0484 Reactive Species Identified in Diamond-Film Process

0485 Thermographic Inspection of Cottings—A new use is proposed for existing equipment. (Licensing Opportunity)

0486 Stabilizing Silicon-Ribbon Growth at Early Stages—A simple mechanism prevents silicon buttons from tipping. (Licensing Opportunity)

0487 Low-Dielectric Polyimides—Dielectric constants as low as 2.4 are achieved. (Licensing Opportunity)

Testing & Instrumentation

0488 Naval Air Development Center Tests SMOOPI

0489 Protective Coatings on Metals Evaluated

0490 An Automatic, Quantitative Image Analysis System for Construction Materials

Other Items of Interest

0427 Oil from Meadowfoam Plants

0436 An Inexpensive Rapid Annealing Apparatus (Licensing Opportunity)

0445 Lightweight Nickel Composite Electrode (Licensing Opportunity)

Development of Magnesium Alloys for Aerospace Use

Several magnesium base alloys are being investigated for potential use in aerospace applications in studies under way at the University of Illinois under Air Force Office of Scientific Research sponsorship. These include Mg-Gd, Mg-Si, and Mg-Li-Si alloys.

Studies of Mg-Gd alloys have concentrated on examination of the correlation between microstructure and mechanical properties. Precipitation hardening was examined in alloys containing either 10 or 20 percent gadolinium. Both alloys showed strengthening as a result of precipitation hardening treatments. Although higher strength could be attained in the alloy containing 20Gd, a better combination of strength and ductility was found in the Mg-10Gd alloy. Tensile properties of the Mg-10Gd alloy solution heat treated from 995 F (535 C) and precipitation hardened for 2 hours at 570 F (300 C) were as follows:

Yield strength	14 ksi
Tensile strength	27 ksi
Elongation	11.6 percent

Further studies are planned to develop improved heat treatments for the Mg-Gd alloys.

Rapidly-solidified Mg-Si alloys containing from 0.5 to 8 percent silicon were prepared in efforts to develop dispersion-strengthening. It was concluded that attractive alloys for elevated temperature use could be based on the Mg-5Si composition; this composition appeared to produce the best dispersion microstructure of those alloys studied. The microhardness of melt spun Mg-Si alloys as a function of silicon content is shown in Figure 2.

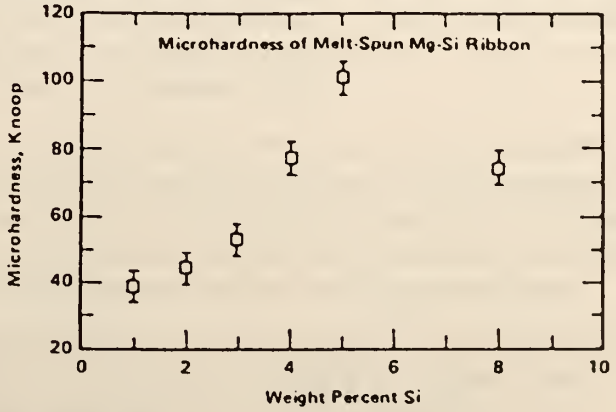

Figure 2. Microhardness (Knoop, 50 Gram Load) of the Melt-Spun Ribbon as a Function of Si Content

Rapidly-solidified Mg-Li-Si alloys are being examined to determine whether the presence of a silicide dispersion would improve the creep properties of Mg-Li alloys. It was found more difficult to produce a uniform silicide dispersion in Mg-Li-Si alloys than in Mg-Si alloys, lower Si contents appear to be mandatory. Further studies are planned to determine appropriate compositions and processing methods to produce finely dispersed silicides in Mg-Li alloys.

FOR ADDITIONAL INFORMATION: A copy of the report is available from NTIS, Springfield, VA 22161; (703)487-4600.

NTIS order number: AD-A187953/NAR

Price code: A05

Fracture Behavior of Al-Fe-X Alloys

Appreciable development effort in recent years has been directed toward the exploitation of aluminum dispersion alloys containing stable iron-based dispersion additions for service at high temperatures (above 450 F [230 C]). These alloys, which are processed using power metallurgy techniques, have been shown to exhibit very attractive strength and creep resistance at high temperatures, but toughness has been disappointing. A study is underway at Southwest Research Institute (SwRI), supported by the Air Force Office of Scientific Research, to determine factors responsible for the poor toughness of alloys of this type, with the objective of developing procedures for improving toughness. The results of the second year of research on this study are described in a recent report.

Four alloys are under investigation in this program. The composition of these alloys, and the characteristics of the dispersions present in the alloys as determined by studies conducted at SwRI, are shown in Table 1. The dispersed phase in the Al-8Fe-1.4V-1.7Si was reported to be coherent with the matrix; the other three alloys showed non-coherent dispersions. Tensile and fracture properties have been determined for these alloys at both room temperature and 600 F. KIC values (LT orientation) were less than 10 MPa m1/2 (9.11 ksi _ in. to the 1/2 exponential power) at both temperatures for three of the alloys, but the silicon-containing alloys showed values of 39.4 and 14.9 (35.88 and 13.57 ksi _ in. to the 1/2 exponential power) at room temperature and 600 F, respectively. Reasons for this unusual toughness behavior are discussed by the authors. Studies of the crack tip fracture processes indicated that void nucleation at 0.1 to 1 _m particles, which rapidly coalesced to form cracks, controlled the fracture in the three Si-free alloys. Internal delamination, apparently related to oxides present at the splat-cooled particle surfaces, were a factor in fracture behavior of the Si-containing alloy.

Based on the results achieved thus far in this investigation, it was suggested that toughness of Al-Fe-X dispersion alloys could be increased by elimination of large particles, such as Al-Fe intermetallics, reduction of the dispersion size to less than 0.01 _m, strengthening the matrix, and thermomechanical processing to control the splat-cooled particle boundary orientation.

FOR ADDITIONAL INFORMATION: A copy of the report is available from NTIS, Springfield, VA 22161; (703)487-4600.
NTIS order number: ADA192909/NAC
Price code: A03

New Windshield to Improve Birdstrike Protection

A new windshield can withstand strikes by birds weighing up to four pounds with the aircraft traveling at speeds as high as 550 mph (480 knots). Present windshields for the A-7 aircraft resist four-pound birdstrikes up to only to 178 mph (155 knots).

The new A-7 windshield is made of multiple layers of polycarbonate material sandwiched between two layers of acrylic. Polycarbonate is a very strong, but pliable transparent plastic sometimes used in commercial or consumer products. Acrylic is harder and is used to protect the polycarbonate from scratches or abrasive damage.

The new design uses a frame which incorporates composite materials to help transmit the shock of the birdstrike from the windshield into the aircraft fuselage, where the shock dissipates. The design eliminates the horseshoe-shaped frame which connects the three pieces of the present transparency. With a single, large transparency, the new windshield has 20 percent more viewing area and requires 30 percent fewer spare parts to maintain.

While the new windshield absorbs almost 10 times the impact energy of the old design, it weighs the same. It also permits use of a wide field of view HUD and night vision goggles.

FOR FURTHER INFORMATION CONTACT:

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U.S. Army Fact Sheet

Stress Relaxation Behavior of 38664 Titanium Alloy

Service requirements for cannon have recently begun to include more stringent demands for light weight and ability to withstand exposure to high temperatures. As a result, interest has been generated in the possibility of producing cannon from compound cylinders, replacing part of the conventional steel cylinder with an outer cylinder of a temperature-resistant, light-weight titanium alloy. Studies to develop property data for use in assessing the feasibility of this concept are descibed in two recent reports issued by the Benet Laboratories. Among properties evaluated in those studies were elastic modulus, tensile properties, fracture toughness, stress relaxation, and notched fatigue life. Properties were determined as a function of both temperature and orientation of the test specimen.

The titanium alloy evaluated was 38644, a beta titanium alloy with a nominal composition of 3Al, 8V, 6Cr, 4Mo, and 4Zr. The microstructure of this alloy, which was apparently procured in the as-extruded form, consisted of a mixture of fine equaxed grains arranged in axially-aligned bands in a matrix of unrecrystallized-appearing material. In general, elastic, tensile, and fracture toughness properites measured in the titanium alloy, although exhibiting appreciable scatter, agreed with published information.

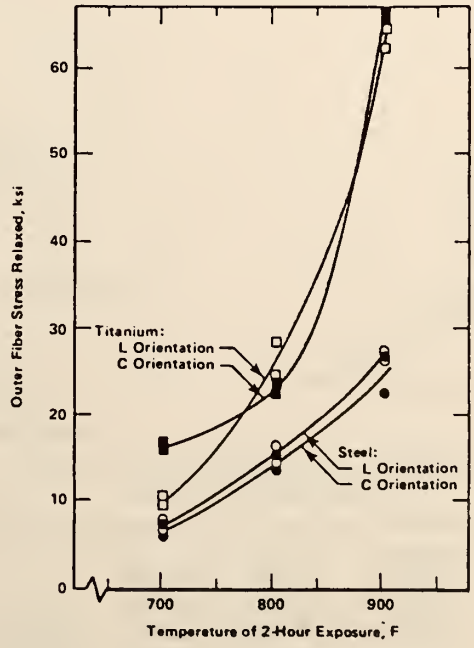


Figure 1. Effect of Exposure Temperature on Amount of Stress Relaxed From Steel and Titanium Specimens Loaded to 690 MPa (100 ksi) Initial Elastic Outer-Fiber Stress[1]

Figure 1 shows the amount of relaxation observed in longitudinal (L) and circumferential (C) specimens removed from the extruded beta titanium alloy cylinder and heated under stress for 2 hours at temperatures between 700 F and 900 F while held in a bend mandrel under an initial applied outer fiber bending stress of 100 ksi (690 MPa). As shown in Figure 1, relaxation was significantly greater at 900 F (480 C) than at 700 F (370 C). Orientation had relatively little effect on relaxation behavior.

Rapidly-solidified Mg-Li-Si alloys are being examined to determine whether the presence of a silicide dispersion would improve the creep properties of Mg-Li alloys. It was found more difficult to produce a uniform silicide dispersion in Mg-Li-Si alloys than in Mg-Si alloys, lower Si contents appear to be mandatory. Further studies are planned to determine appropriate compositions and processing methods to produce finely dispersed silicides in Mg-Li alloys.

FOR ADDITIONAL INFORMATION: A copy of the report is available from NTIS, Springfield, VA 22161; (703)487-4600.

NTIS order numbers: ADA196O46/NAC and ADA196329/NAC

Price code: A03

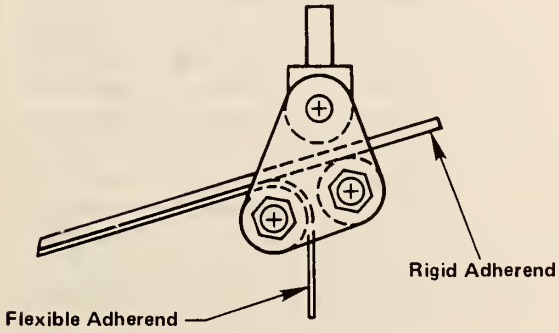
Metals and Ceramics Information Center

CAB
Current Awareness
Bulletin

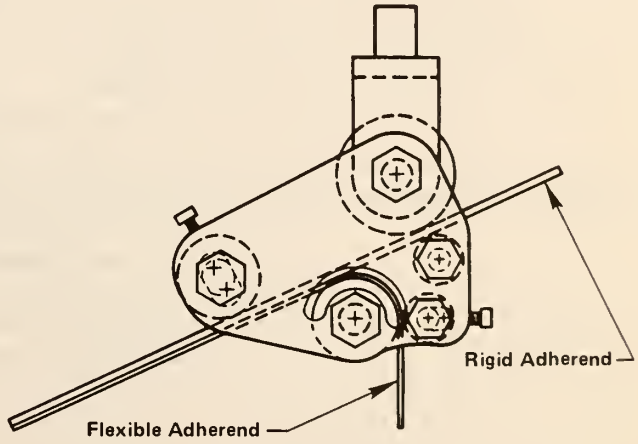
Improvements in the Floating Roller Peel Test for Adhesives

Adhesively bonded joints are often used with aluminum alloys in aircraft applications. Studies related to this use have been conducted at the University of Dayton Research Institute to improve the floating roller peel test, ASTM D3167, used to measure the strength of metal-to-metal adhesive bonds. The test as presently used was considered to have two major deficiencies. First, it was not possible to separate the work required to bend the flexible adherend from that required to fail the adhesive. Second, the mode of failure of both very weak and very strong adhesive bonds was such that the flexible adherend often failed to conform to the geometry of the test fixture, leading to erratic test results.

An improved tool design was developed to force the flexible adherend to conform to the geometry of the roller regardless of the strength of the adhesive bond. The improved fixture is compared to the current fixture in Figure 1. Note that additional rollers have been added to the test fixture.



b. Current Design (ASTM D3167)



a. Improved Design

Figure 1. Floating Roll Peel Test Fixtures

Table 1. Measurements of Adhesive Strength Using an Improved Floating Roller Test[a]

Type of Adhesive	Thickness of Adherend, in.	Measured Work to Fail Bond, in.-lb/in.	Calculated Work to Bend Adherend, in.-lb/in.	Work to Fail Adhesive (By Difference), in.-lb/in.
Low strength	0.020	5.04	4.17	0.87
Low strength	0.040	24.81	22.49	2.32
High strength	0.020	30.68	4.17	26.51
High strength	0.040	42.76	22.49	20.27

(a) Results given in the table represent the average of two tests.

In order to separate the work required to bend the flexible adherend from that required to fail the adhesive bond, a model of the bending process was developed that permitted the bending force to be calculated from knowledge of the mechanical properties and dimensions of the flexible adherend.

The results of tests of bond strength made on four bonded aluminum alloy 6061-T6 panels, two bonded with a weak adhesive and two bonded with a strong adhesive, with the improved fixture and shown in Table 1. Two flexible adherend thicknesses were used in these test, 0.020 inch and 0.040 inch. If the analytical model used to determine the bending strength of the flexible adherend was accurate, one would expect the bond strength of the adhesive to be independent of the flexible adherend thickness. As shown in Table 1, this was not the case; some improvements in the model used to calculate bending strength are needed. However, it is apparent that the use of the improved fixture, in conjunction with the analytical solution in its present state of development, provides a much better estimate of adhesive bond strength than that available using the current test with no correction for the work required to bend the flexible adherend.

FOR ADDITIONAL INFORMATION: A copy of this report is available from NTIS, Springfield, VA 22161; (703) 487-4600.
NTIS order number: ADA194114/NAC
Price code: A04

NAVY
Domestic Technology Transfer Fact Sheet

Reactive Species Identified in Diamond-Film Process

A team of researchers at Naval Research Laboratory (NRL), Washington, D.C., reports they have made the first direct measurements of the gaseous molecules present during the growth of man-made diamonds derived from low-pressure gasses.

The NRL scientists are conducting these studies to attain an understanding of the chemistry of reactive gasses and mechanisms of the diamond chemical vapor deposition (CVD) so that they can control the size, shape, and properties of the synthetic diamonds.

Diamond, a metastable form of crystalline carbon, is grown when a dilute low-pressure mixture of methane and hydrogen is passed over a hot tungsten filament above a heated substrate. This vapor phase-method results in small, microscopic crystals that merge to form a thin diamond film.

Diamond is the hardest material known to man, and it has excellent optical transparency, from the deep infrared to the ultraviolet. Additionally, diamond is an excellent thermal conductor, four times better than copper; it is ideal for high-speed, high-temperature, and high-power semiconductor devices; it has a low coefficient of friction, similar to that of Teflon; and, it has a strong resistance to radiation damage.

Off-the-shelf diamonds cannot meet many of the desired technological needs because they are difficult to process into devices, but through chemical vapor deposition, the shapes and properties necessary for commercial uses can be developed.

For Additional Information:

Backup material on this effort is available from:

Navy Domestic Technology Fact Sheet Reader Reply Service
Code E211
Naval Surface Weapons Center
Dahlgren, VA 22448-5000
(703) 663-8921

Refer to 140102/TN

NASA Tech Brief
National Aeronautics and Space Administration
Marshall Space Flight Center, Alabama

Licensing Opportunity

Thermographic Inspection of Coatings

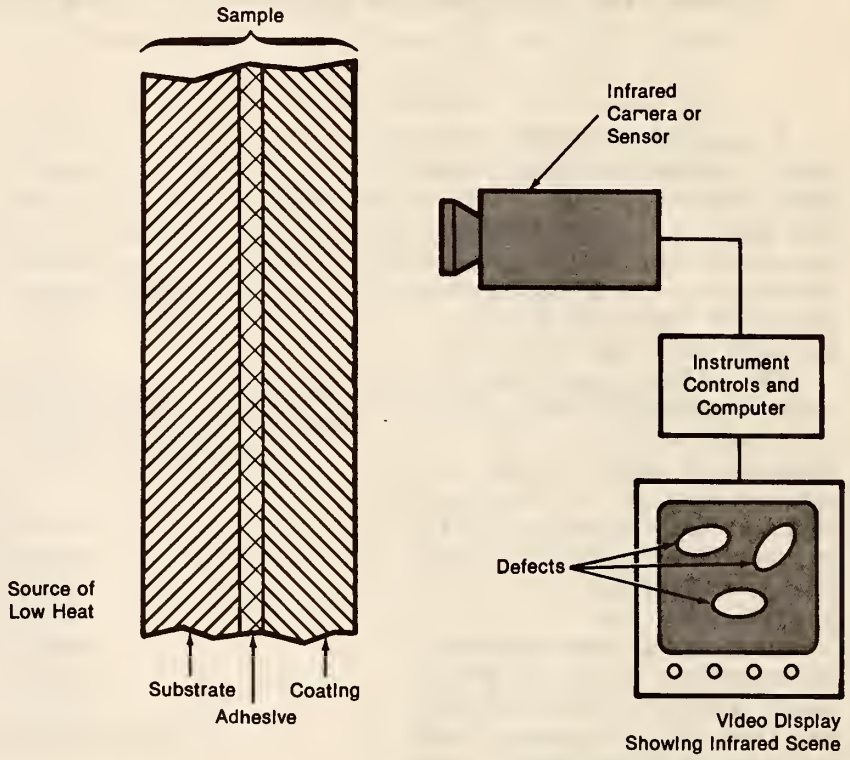
A new use is proposed for existing equipment.

The use of infrared thermography has been proposed for the inspection of some kinds of coatings — especially those intended to provide thermal protection. By the use of commercially-available infrared thermographic equipment, it may be possible to identify defects, including areas of poor adhesion.

A source of heat would be placed behind the sample to be inspected, and the sample would be viewed through the thermographic equipment (see figure). Depending on the specific thicknesses and types of materials in the sample, it may be preferable for the camera to view the coating side or the substrate side of the sample. Defects would be seen on the monitor as islands of different temperature. This inspection technique could be executed by remote scanning or by robotic scanning with automatic electronic detection of anomalies.

This work was done by W. A. Riehl and P. W. Hayes of United Technologies for **Marshall Space Flight Center**. *No further documentation is available.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center [see page 20]. Refer to MFS-28258.



A **Sample Heated Radiantly From Behind** would be viewed by infrared thermography. Defects in the coating would be visible at infrared wavelengths.

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FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*
REFER TO THE NUMBER LISTED AT THE END OF THIS ARTICLE

NASA Tech Brief
National Aeronautics and Space Administration

Licensing Opportunity

NASA's Jet Propulsion Laboratory, Pasadena, California

Stabilizing Silicon-Ribbon Growth at Early Stages

A simple mechanism prevents silicon buttons from tipping.

A device mechanically stabilizes the buttons from which silicon ribbons are grown by the dendritic-web process. The device eliminates the tendency for a button to tip and interrupt a pull because of asymmetry.

Previously, the buttons used to start growth had to be kept narrow to minimize the effect of asymmetry. Several hours of growth were then needed to approach full ribbon width. With the new device, a large button can be used. Even if the button assumes a highly-asymmetrical weight distribution in the early stages of growth, there is little danger of tipping and breakage of the nascent ribbon.

The device includes a tube with enlarged ends, made of quartz, molybdenum, or other refractory material (see figure). A supporting wire attaches the tube to a sliding mechanism, which in turn is attached to a tape that pulls the ribbon from the molten silicon. A seed holder on the pulling tape suspends a silicon seed that extends to the surface of the melt by passing through the tube. The button grows from the seed across the surface of the melt. When the button reaches the proper size, pulling begins; the tape carries the seed, the entire stabilizing mechanism, and the button upward.

After about 2 mm of upward travel, the sliding mechanism is moved downward until the supporting wire releases the full weight of the tube onto the button. The weight is enough to offset the unbalancing effect of any asymmetrical weight distribution in the button.

This work was done by Paul K. Henry and Edward P. Fortier of Caltech for **NASA's Jet Propulsion Laboratory**.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Resident Office-JPL
Refer to NPO-17074/TN

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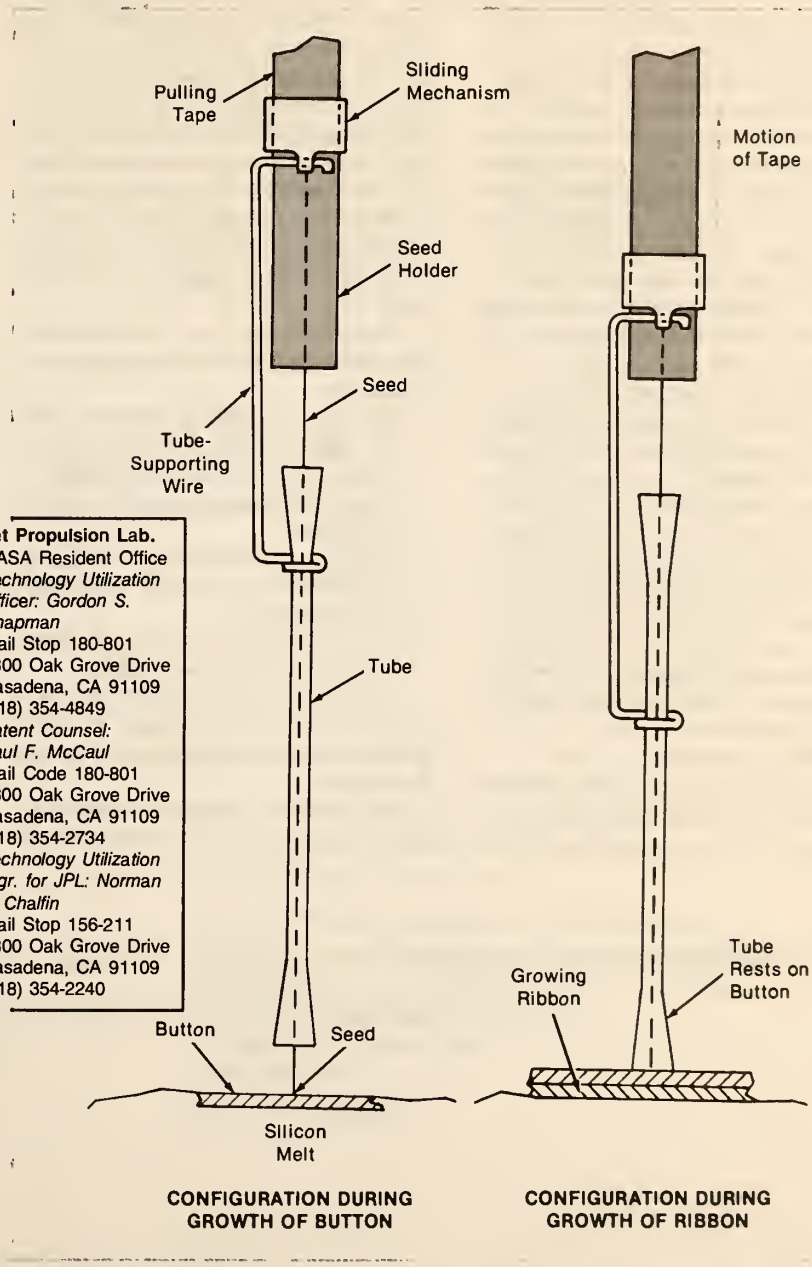

A Silicon Seed Hangs From a Holder through a stabilizing tube. While the button is growing, the tube is elevated above the melt surface. When the button is ready for the pulling of the ribbon, the tube comes to rest on the button and prevents it from tipping.

FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*
REFER TO THE NUMBER LISTED AT THE END OF THIS ARTICLE

NASA Tech Brief
National Aeronautics and Space Administration
Langley Research Center, Hampton, Virginia

Licensing Opportunity

Low-Dielectric Polyimides

Dielectric constants as low as 2.4 are achieved.

Linear aromatic condensation polyimides are being used increasingly by the electronic circuit industry as high-performance film and coating materials. The dielectric constants of commercially available polyimides currently used as passivants and interlevel dielectrics range from approximately 3.2 to 4.0. The lower limit of 3.2 is attained only in fully desiccated films. As a film or coating absorbs moisture, the dielectric constant rises, thereby complicating measurements and the operation of electronic devices.

A new process has been developed to produce aromatic condensation polyimide films and coatings that have dielectric constants in the range of 2.4 to 3.2. These materials are better electrical insulators than are state-of-the-art commercial polyimides. Several of these low-dielectric-constant polyimides have excellent resistance to moisture. They should prove highly useful as film and coating materials for both industrial and aerospace applications where high electrical insulation, resistance to moisture, mechanical strength, and thermal stability are required.

The process for producing these low-dielectric aromatic polyimides involves two conditions: (1) the suppression of chain/chain electronic interactions in the polymer by alteration of the molecular structure and (2) the incorporation of fluorine atoms into the backbone of the polymer. Adherence to the first condition results in a polyimide with a dielectric constant below 3.2. For maximum insulative properties, however, both conditions must be met to produce a moisture-resistant polyimide with a dielectric constant in the range of 2.4 to 2.8.

Chain/chain electronic interactions are suppressed by one or more of the following measures:

1. Reducing the acidity of the dianhydride monomer or basicity of the diamine used to make the polyimide by the addition of separator or linking groups to the molecular structure;
2. Incorporating physical "kinks" in the polymer chains by use of meta-linked diamine monomers; and
3. Incorporating bulky groups that hinder the interactions between chains.

Fluorine atoms are added to the backbone of the polymer by use of $-CF_3$ groups in both the dianhydride and diamine monomers.

This process is applicable to the production of high-temperature and moisture-resistant adhesives, films, photoresists, and coatings. It is of particular value for such electronic applications as printed-circuit boards, both of the composite and flexible-film types. The low-dielectric polyimides produced by this technique have considerable potential for use in the automotive, aerospace, and electronic industries.

This work was done by Anne K. St. Clair, Terry L. St. Clair, William P. Winfree, and Bert R. Emerson, Jr., of **Langley Research Center.**

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Langley Research Center
Refer to LAR-13769/TN

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REFER TO THE NUMBER LISTED AT THE END OF THIS ARTICLE

NAVY
Domestic Technology Transfer Fact Sheet

Naval Air Development Center Tests SMOOPI

The Naval Air Development Center (NADC), Warminster, Pennsylvania, is testing a low-cost, lightweight device used for field inspecting impact damage and resultant flaws in aluminum honeycomb sandwich and laminated composite materials used in naval aircraft. These inspections assure that composite structures provide the same level of structural reliability as comparable metal structures. The device is the Shadow Moiré Out-of-Plane Interferometric (*SMOOPI*) Damage Detector.

The detector consists of a lightweight battery power source, a 4- by 5-inch moiré (a wavy pattern) screen, and a pistol grip and is capable of detecting surface anomalies of .0001 inch. It has several advantages over existing inspective techniques. The detector is a fast, simple, accurate, portable, inexpensive device that can be used in the field by personnel who have been given minimal training; and it eliminates the tedious scanning procedures required to inspect large structures.

Investigators at NADC created the detector as part of an independent exploratory effort. *SMOOPI* works on the interference fringes created by the supposition of two grids or the shadow moiré technique. These shadows are distorted by the out-of-plane elevation or depth of the surface. When viewed with *SMOOPI*, moiré fringes are created that represent the topology of the specimen's surface--similar to a contour map. A damaged area can be quickly identified; then ultrasonics can be used at selected locations to further define the nature of the damage.

SMOOPI has been demonstrated at the Naval Air Systems Command in Washington, D.C., and was favorably received.

For Additional Information:

Backup material on this effort is available from:

Navy Domestic Technology Fact Sheet Reader Reply Service
Code E211
Naval Surface Weapons Center
Dahlgren, VA 22448-5000
(703) 663-8921

Refer to 140106/TN

NIST Technology Update

National Institute of Standards & Technology
(Formerly the National Bureau of Standards)
U.S. Department of Commerce, Gaithersburg, MD 20899

Protective Coatings on Metals Evaluated

Researchers at the NIST Center for Building Technology have developed a fast, reliable technique for evaluating the performance of organic coatings used for controlling metallic corrosion. In addition to being a threat to the safety and reliability of structures and products, metallic corrosion annually costs the United States an estimated $160 billion. About one-fourth of this cost is for paints, platings, or other surface coatings used to combat corrosion. While other evaluation methods are available, they often are time consuming, sometimes taking months, or may require expensive equipment. The new NIST electrochemical technique is quick (15 minutes to several hours depending on the coating), reproducible, and causes very little perturbation to the coating. In addition, the testing procedure is simple and uses commonly available instrumentation. The method also is believed to have other applications such as screening new coatings and corrosion inhibitors and evaluating the effect of new surface preparation techniques on the performance of the coating and metal system.

FOR ADDITIONAL INFORMATION: A report, An Electrochemical Technique for Rapidly Evaluating Protective Coatings on Metals (NIST Technical Note 1253), is available from NTIS, Springfield, VA 22161; (703)487-4600.

NTIS order number: PB89-134209/NAC.
Price code: A03.

An Automatic, Quantitative Image Analysis System for Construction Materials

Research work has developed an automatic quantitative image analysis (AQIA) software system specially designed for materials'analysis. It is implemented on a UNIX operating system with a Tektronix graphics terminal as a monitor. Compared with many image analyzers, it is almost hardware independent. With a few changes, it can be run on any UNIX operating system with any high resolution monochromatic monitor. With some additional changes it can also be transported to a microcomputer with an appropriate graphic terminal. Therefore, it is much less expensive than the existing hardware-type automatic image analyzers. It is specially developed for quantitative microscopy of construction materials.

This system tries to combine the advantages of manual examination and automatic image analysis. It has some unique features. It simulates the process of human segmentation to make this process more realistic. It labels objects to make individual measurements easy. With labeled objects, AQIA can process an image more accurately and with more flexiblility than can a non-labeling analysis system. Because the reliablility of image measurement depends on the accuracy of image segmentation and processing, AQIA is expected to provide more reliable measurements.

AQIA can have a variety of specific applications to cement and concrete research. Image analysis may be the only reliable technique for some measurements such as the distribution of big pores in concrete and flyash particle sizes. AQIA can provide solutions to these kinds of difficult measurements. However, the aim in the development of the AQIA system has been to produce a package of programs that are generally applicable to the broad spectrum of construction materials research. Thus, specialized programs that produce only one result have been avoided. It is hoped that this has produced a package that will be broadly applicable to researchers.

This system provides a means to measure many discrete fields of view, in order to obtain statistically meaningful results. The system can process images from either an electron or light microscope, or from an ordinary camera. Either negatives or positives can be used. A new method based on fuzzy probability has been developed to segment digital images into binary images. It is more consistent than existing techniques. The accuracy of the system has been verified with images having known geometric properties. Measurements have an error of less than 1% with an image of appropriate resolution. The system makes different measurements on separate particles and cut planes through massive samples.

FOR ADDITIONAL INFORMATION: A copy of the report is available from NTIS, Springfield, VA 22161; (703)487-4600.
NTIS order number: PB89-116982/NAC
Price Code: A03

Medicine & Biology

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0444 Computerized Utility Cost-Reducing Procedure is Available

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U.S. Department of Health and Human Services Public Health Service National Institutes of Health

Federal Laboratory Resource

Caenorhabditis Genetic Center

Principal Investigator:
Donald L. Riddle, Ph.D.
Professor of Biological Sciences
Tucker Hall
University of Missouri
Columbia, Missouri 65211
(314) 882-7384

Resources Provided

- *Animals:* Genetic stocks of *Caenorhabditis elegans* and other *Caenorhabditis* species are made available for use by investigators initiating or continuing research on this nematode. The center's collection of more than 1,200 strains includes at least one allele of each identified gene, all available chromosome rearrangements, and selected multiply mutant stocks useful for genetic mapping. Requests for strains should include a brief statement of the research or training activity for which they are intended. Recipients affiliated with nonprofit organizations are asked to pay postage costs.
- *Other Services:* The center is responsible for annual revision of the *C. elegans* genetic map, coordination of genetic nomenclature, and maintenance of a complete bibliography of *C. elegans* research publications. The collected data are made available to investigators on computer diskette and in hard-copy form. The *C. elegans* research newsletter, the "Worm Breeders Gazette," is distributed to approximately 300 subscribers.
- *Contact Person:* Mark L. Edgley, B.A., curator, (314) 882-7384.

Research Emphasis or Application

- *Basic Objectives:* To develop an efficient computerized data base management system for storage and access to (1) genetic and phenotypic descriptions of strains in the collection; (2) the bibliography of research publications including key words assigned by the center; (3) all freezing, thawing, and mailing records for genetic stocks; and (4) the raw data used to generate the genetic map. A separate computer graphics program used for drawing the map itself is to be used for semi-annual updates and for special-purpose maps. The center also acquires new strains that are described in current literature, and evaluates methods for permanent storage of genetic stocks.
- *Current Research:* Resolution of conflicting genetic data received from research laboratories, improving the resolution of the genetic map, and alignment of the genetic and physical maps.

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Federal Laboratory Resource

Living Protozoa (Protozoa and Algae)

Coprincipal Investigator:
Pierre-Marc Daggett, Ph.D.
Head, Protistology Department
American Type Culture Collection
12301 Parklawn Drive
Rockville, Maryland 20852
(301) 231-5516

Director:
Robert E. Stevenson, Ph.D.

Resources Provided

- *Protistan Strains:* A collection of over 1,000 living strains of well-characterized protozoa and algae representing 11 phyla, 126 genera, and 348 species are available. Parasitic, free-living, and strains with special applications are available. A catalogue with data, growth conditions, and selected references on strains is available. The catalogue is accessible electronically through the CODATA network on the international DIALCOM system. Both the specific strain entries and the listing of strains in the collection according to the generally accepted taxonomy are included.
- *Other Services:* Services available include electrophoretic isoenzyme analysis, preparation of strains in laboratory scale quantities, and identification of strains.

Research Emphasis or Application

- *Basic Objective:* To acquire, preserve and distribute well-documented protistan strains of use to the biomedical and biotechnological sectors.
- *Application of Service:* Strains are available for a fee through the ATCC Sales and Marketing Department by mail, on-line DIALCOM network 142:CDT0109, TELEX (USA & Canada) 908768, FAX (301) 231-5826 and by telephone (800) 638-6597 except Maryland (301) 881-2600

Federal Laboratory Resource

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U.S. Department of Health and Human Services Public Health Service National Institutes of Health

Repository of Human DNA Probes and Libraries

Principal Investigator:
William C. Nierman, Ph.D.
Head, Department of Molecular Biology
American Type Culture Collection
12301 Parklawn Drive
Rockville, Maryland 20852-1776
(301) 231-5559

Resources Provided

- *Cloned Human Genes and DNA Probes:* A collection of well-characterized cloned human genes and anonymous DNA probes is maintained as a source of materials for investigators conducting linkage analysis or gene structure, function, expression studies. Materials in the repository are available as *Escherichia coli* containing plasmid DNA or infectious bacteriophage lambda particles. In addition, repository materials can be obtained in 5 microgram aliquots as purified DNA.
- *Human Libraries:* The repository maintains and distributes the chromosome-specific libraries constructed from flow sorted chromosomes by the Department of Energy's National Laboratory Gene Library Project. Other human genomic and cDNA libraries are also available.
- *Data Base:* The repository maintains an extensive data base of information on available materials. The data base is available online through the CODATA/MSDN Network and through direct dial into the ATCC computer. It is a menu-driven, user-interactive system that is searchable by novice users.

Research Emphasis or Application

- *Basic Objective:* To provide the human-molecular-genetics community with a centralized source of probes to accomplish the genetic mapping of the human genome. A particular emphasis is to make available probes that are useful for mapping human genetic diseases.
- *Application of Service:* Materials are available for a fee established by the National Institute of Child Health and Human Development. Repository materials cannot be used for commercial purposes.
- *Contact Person:* William C. Nierman, Ph.D., (301) 231-5559.

Research Technology
Argicultural Research Service
U.S. Department of Agriculture

Height-Weight Tables Replaced by Fat-to-Lean Ratios

There's new hope for people who dread height-weight tables—those insurance company formulations of how much you should weigh, based on your height and frame size.

The troublesome tables might someday be edged out by handy charts of fat-to-lean ratios, says research physiologist Marta Van Loan at ARS' Western Human Nutrition Research Center in San Francisco.

And those ratios may prove to be a fairer and more accurate gauge of fitness. Because muscle is heavier than fat, the trim, well-muscled person who works out regularly may show up as overweight on the conventional height-weight tables. If measured for fat-and-lean, however, every ounce of muscle boosts the fitness rating.

But updated fat-to-lean ratios for people of different bone structures, ages, and ethnic groups must be compiled before this approach to measuring fitness can become as well known and as widely used as the traditional tables, Van Loan says. Current standards for "healthy" fat-to-lean ratios are based only on measurements of white men and women ages 20-35.

To fill in the missing information about other people's ideal ratios, Van Loan is experimenting with several different electronic instruments for measuring body fat, ranging from portable, hand-held devices to the large TOBEC machine, originally designed for the meat industry to measure fat in pigs and other animals. Researchers at Columbia University's School of Medicine in New York City were the first to come up with the idea of using the meat-monitoring machine to measure people. ARS researchers worked with the manufacturer to adapt the instrument for that use.

Van Loan says body fat measurements taken with TOBEC (for "Total Body Electrical Conductivity") are quick, reliable, painless, and just as accurate as readings from the long-established but cumbersome process of underwater weighing.

TOBEC distinguishes fat from lean by emitting the same kind of harmless electrical field that is used in airport metal detectors. Salts of lean tissue—found in muscle and water—easily conduct this electricity. Fat doesn't.

Because it only takes a few seconds to move someone though TOBEC's field, the experimental machine offers researchers an unparalleled opportunity to quickly take fat measurements of large numbers of people, and to use these new measurements to develop updated fat-to-lean ratios.

FOR ADDITIONAL INFORMATION: To discuss this effort further, contact Marta Van Loan at the USDA-ARS Western Human Nutrition Research Center, P.O. Box 29997, Presidio of San Francisco, CA 94129 (415)556-5729.

United States
Environmental Protection
Agency

Health Effects
Research Laboratory
Research Triangle Park, NC 27711

Research and Development

EPA

Project Summary

Behavioral Effects of Microwaves: Relationship of Total Dose and Dose Rate

The goal of this research was to compare the relationship of whole body averaged specific absorption rate (SAR) and specific absorption (SA) to determine if dose rate or dose was a better predictor of biological effects. Sperm positive Long-Evans female rats were exposed to 2450 MHz CW microwave radiation for 1-3 hours at approximately 10 W/kg. The maternal subjects were then observed for natural delivery of their litters. Sensitivity to thermally induced seizures and huddling were studied in the offspring. Analyses revealed that there were no statistically significant differences between exposed and control offspring on the behavioral indices. The behavior did not appear to be effected by prenatal exposure to microwave radiation at these levels. The huddle sizes became smaller as the pups aged both in exposed and control offspring.

This Project Summary was developed by EPA's Health Effects Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The purpose of the investigation was to define the relationship of exposure duration and average whole body specific absorption rate (SAR) of continuous wave (CW) radiofrequency radiation (RFR) using biological endpoints. The research was conducted in two phases. In the first phase, female Long-Evans rats were exposed at SARs of 2, 4, 6, or 8 W kg for durations of 1, 2, 3, 4, 5, or 6 hours. Subsequently, CF-1 mice were exposed at 2, 4, and 8 W kg for durations of 1, 2, 3, 4, 5, or 6 hours. Colonic temperatures were taken immediately before and immediately following each exposure session.

In the second phase of the research sperm-positive Long-Evans female rats were exposed at SARs of 10 W kg for durations of 1 and 3 hours. The exposures occurred on gestational days 12 through 18. The maternal subjects were irradiated and then observed for natural delivery of their litters. The pups constituted the subject pool for subsequent behavioral studies. The behavioral tests included sensitivity to thermally induced seizures and huddle size.

Experimental Procedures

All maternal exposures occurred in a Lindgren 4-Shield RFR anechoic chamber. The sham chamber was located adjacent to the microwave exposure facility and shared the same air flow system with the anechoic chamber. The temperature at the location of the subject differed by no more than 1°C between the anechoic and sham chambers. 2450-MHz CW microwave radiation was emitted from a horn antenna mounted on the ceiling of the anechoic chamber. During exposure, the animals were placed in Plexiglas cylindrical containers that were positioned on top of a bilayer styrofoam platform. The pup seizures in the second phase were performed using a 2450-MHz circularly polarized waveguide placed inside the sham chamber to provide ambient temperature and humidity control.

Results and Discussion

In general the average temperature change (post-minus pre-exposure colonic temperature) for the exposed Long-Evans rats reflected increased colonic temperatures. With two exceptions, (SAR 2W kg for 4 or 5 hours) the colonic temperature increased during the exposure. For a given SAR, the temperature change did not vary considerably as an effect of duration of exposure. However, the sham exposed rats showed a decrease in colonic temperature that is more evident for

longer exposure durations. Any exposure longer than one hour resulted in a colonic temperature decrease in the sham exposed rats.

All treatment variables associated with the characteristics of the maternal subjects and their exposure as well as the variables associated with the litter characteristics and behavioral measures were analyzed using a three factor analysis of variance. Post hoc tests (Tukey HSD) were performed only when a significant main effect was followed by a significant interaction.

As expected, the microwave exposed groups experienced an increase in colonic temperature during exposure. There was a significant difference in temperature change associated with all three of the major variables: exposure condition ($F = 289.98$, $p < 0.001$), duration of exposure ($F = 11.8$, $p < 0.002$), and time of day of exposure ($F = 4.21$, $p < 0.05$). The average temperature change for the microwave exposed groups was 2.04°C. The sham exposed groups had a decrease in temperature with an average of -0.51°C. The one hour groups increased more than the 3 hour groups while the morning exposure groups increased less than the afternoon Groups. There were no significant interactions.

Conclusions and Recommendations

Under identical exposure conditions and identical rates of energy deposition (SAR) the thermal response as measured by colonic temperature is dramatically different for the mouse and the rat. Mice actually decrease their body temperature while being dosed with energy at 2, 4, and 8 W/kg even when the duration of exposure is as long as 6 hours. The thermal response of the microwave exposed mice is not distinguishable from that of sham exposed mice when measured by colonic temperature.

The rats did not display this efficient thermal regulation of body temperature under these conditions of exposure. Levels of radiation at 2, 4, 6, and 8 W/kg raised body temperature to a given degree and the rats maintained this increased temperature for durations of exposure as long as 6 hours. Sham exposed rats showed a reduction in body temperature at all durations of exposure greater than one hour.

The use of colonic temperature as an indication of thermal responsivity results in opposite results in sham exposed and microwave exposed rats but does not indicate differences in sham and microwave exposed mice. Such a dramatic species difference under identical laboratory exposure conditions argues for extreme caution in attempting to generalize to human exposure conditions. In particular, biological effects observed in only one non-human species should be used in establishing human exposure conditions only when the procedure allows for the inclusion of considerable caveats regarding the lack of essential data. The procedure should also ensure that these caveats will be included in the tables or figures used by practitioners in attempting to abide by a recommendation.

In phase 2 there were significant differences in weight gain between the microwave and sham exposed maternal subjects. However, this difference was not accompanied by differences in either litter size or pup mass.

The results of the second phase indicated that post-natal measures of thermally induced seizure sensitivity or huddle size in pre-natally exposed rat pups were not significantly effected by the microwave exposure at 10 W/kg. Two measures were used to determine huddle size. The age of the pups was a significant variable and the proportion of variance accounted for was much greater for one of the two measures. Behavioral research often demonstrates the importance of operational definitions in which variables and procedures are defined by the methods used to measure them. Like species differences, the importance of operational definitions in laboratory research and its interpretation is a basic experimental principle learned by most investigators in the most elementary research methods courses. However, bioelectromagnetics research is replete with investigations relying on one species and one experimental measurement technique. Some of the ambiguities in the data base might be explained by these two basic experimental principles.

Mary Ellen O'Connor and Robert Strattan are with The University of Tulsa, Tulsa, OK 74104.
***Ezra Berman** is the EPA Project Officer (see below).*
The complete report, entitled "Behavioral Effects of Microwaves: Relationship of Total Dose and Dose Rate," (Order No. PB 89-118 640/AS; Cost: $15.95, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
Health Effects Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

Federal Laboratory Resource

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U.S. Department of Health and Human Services Public Health Service National Institutes of Health

AIDS Specimen Bank

The AIDS Specimen Bank, a collection of tissue and sera specimens from patients with AIDS (acquired immune deficiency syndrome) and related diseases, has been established at the University of California, San Francisco. The collection has been an essential tool in the search for an etiological agent and the development of diagnostic tests, as well as for epidemiological studies, says Dr. John S. Greenspan, director of the repository.

Dr. Greenspan, who is professor and chairman of the department of stomatology in the UCSF School of Dentistry and professor of pathology in the UCSF School of Medicine, created the AIDS Specimen Bank in 1982, along with Drs. Marcus Conant and John Ziegler, as a repository of frozen specimens of persistent Kaposi's sarcoma lesions and persistent lymphadenopathy. Soon afterward the investigators also began to collect sera from patients with AIDS. Deposits increased markedly with the start of epidemiological studies of longitudinal cohorts.

The Bank, which receives support from the State of California Universitywide AIDS Task Force via the AIDS Clinical Research Center in San Francisco, the National Institute of Allergy and Infectious Diseases, and the National Institute of Dental Research, as well as from industry and private supporters, now stores more than 17,000 serum specimens and about 2,000 samples of tissue, cells, saliva, and cerebrospinal fluid, according to Yvonne De Souza, M.S., coordinator for the Bank. These specimens have been donated since 1982 by AIDS patients, people with AIDS-related complex and less advanced forms of HIV disease, and by individuals in high-risk groups, health-care workers, and normal control subjects.

"It is important to realize that very few, currently less than 2 percent, of the accessions represent randomly selected patients with HIV infection. Over 98 percent of the deposits relate to specific planned prospective studies," Dr. Greenspan notes. "These sera and tissues then become available, of course, for studies of hypotheses that become apparent after the specimens are collected. These two kinds of uses represent the whole point of specimen banking," he comments.

Since 1983 the Bank has provided more than 30,000 serum samples and about 800 samples of tissues for studies.

The Bank serves as the major repository for many of the cohort studies and important AIDS clinics in the San Francisco Bay area. The largest cohort, the San Francisco Men's Health Study, is currently transferring all specimens to be stored at the Bank. Other studies currently being done by Bank collaborators include an investigation of HIV seroprevalence in asymptomatic pregnant women, one of patients with lymphadenopathy or idiopathic thrombocytopenic purpura, and a study of a large group of intravenous drug users to assess the risk of acquiring HIV and determine the seroconversion rate.

Another study is collecting sera from health care workers who work with or around AIDS patients or who handle laboratory specimens from AIDS patients. In other studies specimens are being collected from AIDS patients with hairy leukoplakia, oral Kaposi's sarcoma, enlarged parotid glands, xerostomia, periodontitis, acute nec-

rotizing ulcerative gingivitis, pharyngeal ulcers, and other oropharyngeal lesions.

The Bank is housed on the sixth floor of the UCSF Health Science West Tower in a newly renovated biohazard room that includes two laminar flow hoods, a biohazard centrifuge, a cryostat, three liquid nitrogen storage freezers, and 10 regular freezers. Two additional freezers are kept empty but operating and are the "surge" freezers in case of equipment failure. All freezers are kept locked and are connected by an electronic system with a loud alarm that will automatically make telephone calls to warn of temperature failure. The temperature of each freezer can be monitored directly on the freezer, on the central console, and by telephone. A computer provides access to information on cohort deposits, individual samples, classes of samples, details of user collaborator studies, and total Bank data.

Biohazard precautions used in the AIDS Specimen Bank include the standard microbiological practices (such as no eating or drinking in the laboratory and no mouth pipetting); special training for all personnel in handling infectious materials; limiting access to the laboratory when experiments are being conducted; performing all work under a Class II biohazard hood; decontaminating all contaminated materials; and informing all laboratory personnel of current infection control policies.

Scientists from academic institutions, government, and private industry may request tissue or serum samples to be sent to them for AIDS-related research. The investigator must inform the Bank in writing of the nature and purpose of the study. Examples of the type of research being performed on requested specimens include testing new HIV assay procedures; new antibody or antigen assays; testing for the presence of autoantibodies; and prevalence of HIV antibodies in various risk groups. After the requests are reviewed by a committee, the investigator is informed whether the Bank can provide the requested specimens.

For Additional Information:

To locate information or professional contacts on this effort, contact:

Research Resources Information Center
1601 Research Boulevard
Rockville, MD 20850
(301) 984-2870

Refer to Volume XIII, No. 2/TN

NIH
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Hypothalamic Hormones Play Role in Circadian Rhythms

Hormones produced by the hypothalamus help maintain normal metabolic circadian rhythms, according to researchers at the University of Pittsburgh School of Medicine. This finding could open new research directions leading to a better understanding of endocrine disorders in which these rhythms are disturbed.

A research team led by Drs. Alan G. Robinson and David B. Jarrett has demonstrated that the hypothalamic peptide hormone corticotropin-releasing factor (CRF) plays an important role in maintaining normal daily variations in levels of ACTH, a hormone that regulates the blood concentration of steroids released by the adrenal glands. The evidence that CRF secretion follows a circadian rhythm was gathered directly by measuring responses of five healthy volunteers to morning and evening infusions of vasopressin, another hypothalamic peptide that has a major physiologic function in causing water retention by the kidneys.

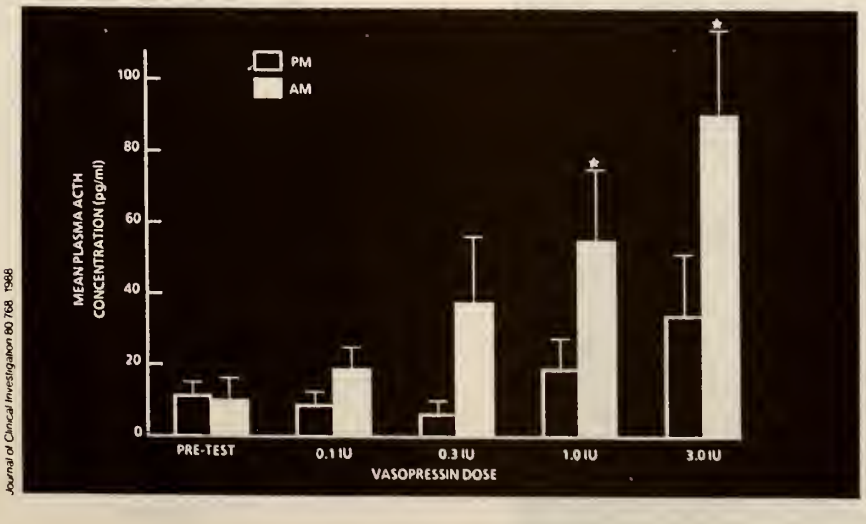
The researchers determined that the hormonal responses to vasopressin infusion can serve as an indirect measure of in vivo concentrations of CRF, the first time such a measure has been found, according to the investigators.

This vasopressin stimulation test can indicate relative levels of CRF secretion, Dr. Robinson says, thereby helping researchers learn what role abnormal CRF secretion may play in certain adrenal diseases and possibly in various types of depression.

CRF travels a short distance from the hypothalamus through portal blood vessels to the anterior pituitary gland in the lower part of the brain, where it stimulates cells to make and secrete adrenocorticotropic hormone (ACTH). ACTH subsequently is carried by the blood to the cortex of the adrenal glands, situated on top of the kidneys; they respond by producing and releasing steroid hormones, the so-called corticosteroids. The major adrenal steroid in humans is cortisol, one of the glucocorticoids, named because of their effects on glucose and protein metabolism. Glucocorticoids are indispensable for normal body function. Cortisol secretion is well-regulated according to a 24-hour cycle, but it often increases during physical or emotional stress.

ACTH and cortisol can be measured with immunological assays, Dr. Jarrett explains. Normal cortisol levels in circulating blood drop from a peak after waking to a minimum in late evening, before rising again during the night and early morning. Secretory bursts of shorter-lived ACTH are also most frequent during early morning, and these bursts modulate daily cortisol rhythm. In turn, ACTH secretion is believed to follow the pattern of CRF release into portal blood.

Unfortunately, "the CRF concentration is too low to measure after the hormone passes from the pituitary gland into peripheral blood," Dr. Robinson says, "and it is not possible to sample portal blood in humans. Some immunological assays of CRF are being developed, and portal blood sampling has been done in animals, but animal models won't necessarily tell us which



Vasopressin and corticotropin-releasing factor (CRF) act synergistically to stimulate secretion of adrenocorticotropic hormone (ACTH) by the anterior pituitary gland. Drs. Robinson and Jarrett infused vasopressin intravenously into human volunteers in the morning (AM) or evening (PM) and measured the blood concentration of ACTH. The significantly higher AM concentrations indicate that humans have higher endogenous concentrations of CRF in the morning than in the evening, according to the investigators.

hormone is most important in controlling the diurnal rhythm in humans."

In both humans and animals, researchers have found that, when given separately, CRF is better than vasopressin in stimulating ACTH secretion. When the two are given simultaneously, however, the combined stimulatory effect is much more than additive. "This synergistic effect was the key observation we used in devising the test," Dr. Robinson says.

The five men and women were studied twice, four weeks apart. During each study they were twice given an identical regimen of infusions. In one study, morning administration of vasopressin followed evening infusions; in the other the order was reversed. During each regimen, volunteers were given an hour to become accustomed to the intravenous line, then were infused with four increasing doses of vasopressin, 15 minutes apart. Blood samples were collected before, during, and afterward; these were analyzed for ACTH and cortisol.

The ACTH and cortisol response to vasopressin was much greater in the morning than in the evening. The results, according to the researchers, suggest that CRF levels, like those of ACTH and cortisol, are normally higher in the morning than in the evening. "We reasoned that the response to administered vasopressin would depend on the level of endogenous CRF. If CRF was low you would get a modest response, if CRF was high you would get a bigger response," Dr. Jarrett explains.

The vasopressin stimulation test may prove useful in learning more about diseases characterized by abnormal ACTH secretion. For example, in the relatively rare endocrine disorder Cushing's disease, excess ACTH secretion leads to fatigue, weakness, hypertension, osteoporosis and sometimes mental disturbances.

"My impression is that, in most cases, Cushing's disease is caused by pituitary tumors, but I see two ways in which the vasopressin test could be used to better locate the source. In cases due to hypothalamic disturbances causing CRF excess, one would anticipate hyperresponsiveness to vasopressin. For cases due to pituitary tumors, it's possible that tumors in different parts of the pituitary may have different receptors for hypothalamic hormones on their cell surfaces, and they may respond differently to medical treatment. We may be able to correlate the vasopressin test with anatomy to help identify the cause and the appropriate medical treatment," Dr. Robinson says.

Drs. Robinson and Jarrett, in collaboration with Dr. Michelle Roberts, a clinical fellow, are now leading studies to track changes of hormone levels in clinically depressed patients. Abnormal CRF secretion has been observed in certain types of depression.

"It's clear that depressed patients may experience disruptions in the normal regulation of the hypothalamic-pituitary-adrenal axis," says Dr. Jarrett.

"However, we are careful to say that CRF is not the only regulator," Dr. Robinson cautions. "There is a rhythm of CRF secretion, but we probably haven't yet identified all the factors involved."

Besides hormones, peptides that transmit signals through nerves may also play a role in regulation, according to Dr. Robinson. These may act on the hypothalamus to influence release of CRF, or they may act directly on the pituitary or adrenal glands, he says. "The role of neurotransmitters such as gamma-aminobutyric acid, vasoactive intestinal peptide, neuropeptide-Y and others is just beginning to be explored, along with previously studied neurotransmitters such as norepinephrine."

"What's not clear, and one of the key things we will be investigating, is what role CRF plays. By using the vasopressin stimulation test we will try to determine if patients have high levels of CRF. Knowing CRF levels may be useful for categorizing different types of depression, for determining its course, and for identifying patients in remission."

For Additional Information:

To locate information or professional contacts on this effort, contact:

Research Resources Information Center
1601 Research Boulevard
Rockville, MD 20850
(301) 984-2870

Refer to Volume XIII, No. 2/IN

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The Molecular Biology Information Resource

The Molecular Biology Information Resource (MBIR) at Baylor College of Medicine in Houston, Texas, offers investigators a comprehensive set of DNA, RNA, and protein analysis software programs with graphics capabilities, embedded in easy-to-use interfaces.

The resource was established in 1985 after an investigator who was conducting computer-aided nucleotide sequence analyses of genes discovered that very little supportive software existed, especially in the UNIX environment.

Soon after developing a collection of software tools that could extract nucleotide and amino acid sequences from GenBank and perform analyses on gene structure, Dr. Charles B. Lawrence, a molecular biologist at Baylor and MBIR director, found that many other investigators at his institution had similar needs.

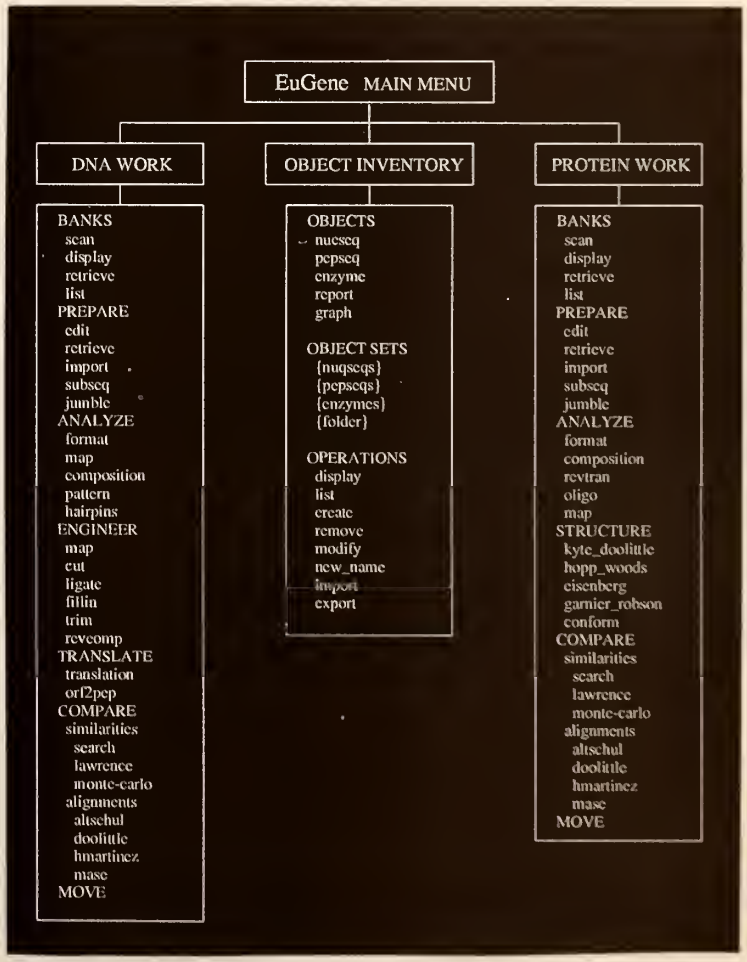
What originated as one investigator's solution to a problem has grown into a resource now being used by more than 180 researchers in 60 different laboratories at Baylor and more than 20 institutions nationally.

Funding for the MBIR is provided by the Biomedical Research Technology Program of the Division of Research Resources of the National Institutes of Health and the Baylor College of Medicine. Two core laboratories funded by the National Institute of Child Health and Human Development — the Reproductive Biology Research Center and the Mental Retardation Research Center — also utilize MBIR's computer services.

The MBIR facility houses a network of Sun Microsystems computer workstations that are connected directly to the main Baylor Information Network Ethernet trunk. There is a local support center for researchers who want to incorporate computer applications into their molecular biological research. This service gives investigators access to MBIR software and demonstration systems with various hardware and software options.

Dr. Lawrence says two newly developed interfaces are the key to the resource, giving investigators with little computer expertise uniform tools to control access to MBIR programs.

"A program we have named EUGENE and another called SAM (Sequence Assembly Management) were designed to allow even the most inexperienced user to exploit the full capabilities of the MBIR programs with a minimum amount of training," Dr. Lawrence says.



EUGENE is constructed as a series of interlinked menus. A selection is made from a main menu that leads to other sets of logically related menus. This illustrates the menus and their linkages.

"The programs can be used without the time-consuming necessity of learning the UNIX operating system. This is particularly appealing to large departmental or universitywide facilities, where limited resources cannot be devoted to software support."

Extensive online and hardcopy documentation is provided with the package for reference, and the MBIR staff members are available to train users and provide consultation. Dr. Lawrence has found that with less than 2 hours of hands-on familiarization most novice users are able to gain easy access to the MBIR programs.

EUGENE is a menu-driven system, complete with concise onscreen advice and extensive online help. It utilizes a comprehensive package of sequence analysis tools that concentrates on similarity searches of sequence data banks and manipulation of sequences for easy analysis.

Sequence similarity searches yield very useful information to identify the function of a specific gene, learn more about protein structure, or trace the assembly of a gene from noncontiguous segments of the genome, Dr. Lawrence says.

An "object inventory" organizes the user's sequences and data objects and is an illustration of the MBIR's object-oriented approach to software development. The inventory includes nucleotide or amino acid sequences and graphic representation of data. This allows the user to maintain different "projects," each with separate object inventories with options for moving data from project to project.

"The object inventory gives the researcher a way to manage data without having to deal with the computer system," Dr. Lawrence says. "It allows the investigator to think about his research in terms of objects he's familiar with, rather than in terms like 'files' and 'directories' that are more familiar to the computer scientist."

Built-in editors are used to enter sequences, to modify the text output produced by the programs, and to keep informal notes in an electronic notepad.

EUGENE's applications are far-reaching and can be used in rapid searches of the nucleotide and amino acid sequence data banks for possible sequence homology, genetic engineering simulation, and protein structure prediction and analysis.

SAM, more recently developed by the MBIR staff, interfaces tools to manage gene-sequencing projects. SAM accepts raw sequencing data, eliminates vector sequences, and assembles the sequences (with a modified sequence alignment algorithm) into sensible long stretches of DNA called "contigs." The investigator can then inspect these contigs and modify them using a corrections editor that gives a visual "big picture" display of the overlapping and unique regions of the structure. The display can then be expanded to focus on the sequences at the nucleotide level, allowing manual introduction of changes in the final consensus sequence while leaving the original structure intact.

FOR ADDITIONAL INFORMATION: For more information, contact: Dr. Charles B. Lawrence, Department of Cell Biology, Baylor College of Medicine, 1 Baylor Plaza, Houston, Texas 77030; Telephone: (713)799-6226.

NIH
Research & Technology
U.S. Department of Health and Human Services Public Health Service National Institutes of Health

Retrievable Sponge Technique Provides Model for Host-Cancer Cell Interactions

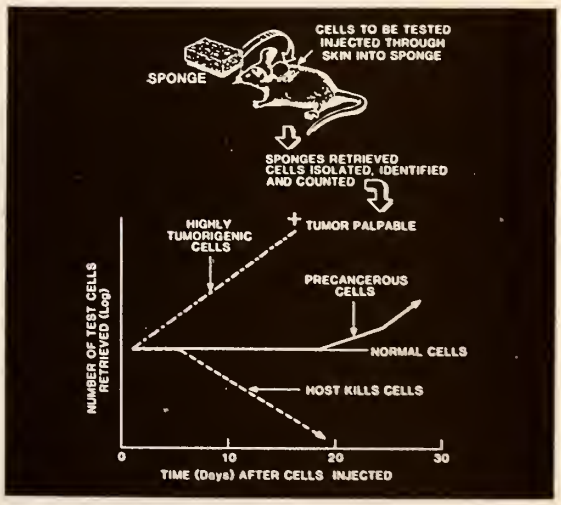
To study how cancer cells develop in the body of an animal, Dr. Paul Kraemer, a biologist at the Los Alamos National Laboratory in New Mexico, and his associates have developed a method of growing cultured cancer cells in surgically implanted gelatin sponges and later retrieving the cells. This "gelatin-sponge model" of tumor growth helps to bridge the gap between the controlled, self-contained environment of a cell culture and the more complex biological setting of naturally occurring tumors.

Dr. Kraemer and other scientists believe that some underlying mechanism may disrupt the DNA in a cell's chromosomes, turn on various cancer-related oncogenes, and lead to malignant cell growth. "Oncogenes are certainly involved in cancer, but they don't really explain the process as a whole," he says.

He and his associates hypothesize that chromosomal instability often is the primary cause of the uncontrolled growth of cancer cells. The Los Alamos investigators are searching for abnormal, "root-cause genes" that cause permanent disruption of the genetic stability of cancer cells. This "hypermutability" of the cancer cell and its descendants gives rise to many variants of the original cell. As cancer progresses, the tumor becomes dominated by increasingly aggressive cells, Dr. Kraemer says.

By using cell culture techniques, the Los Alamos investigators can observe cells over long periods of time and look for cellular changes associated with neoplastic, or cancerous, cell growth. Cultured rodent cells are "passed" through a series of growth cycles: During each cycle, the cells are allowed to grow for several days, then some of the cells are removed and transferred to a new container.

Dr. Kraemer calls the sponge model a "retrievable arena of in vivo growth" that can be removed at various times during the tumor-generation process. In effect, the sponges serve as transportable cell cultures that can be moved temporarily into experimental animals and then returned to the laboratory for analysis. By injecting cultured tumorigenic Chinese hamster cells into sponges that have been implanted in mice, the investigators can study how the foreign cells interact with the host at various stages during their growth. "We want to know how cancer cells change during their in vivo sojourn," Dr. Kraemer says.



Implanting gelatin sponges into nude mice permits analysis of the early stages of tumor development. This illustration represents the several paths of development that the injected cells can take in the nude mouse. Some cells grow, producing tumors. Some are attacked by the host and then disappear. Normal cells are not allowed by the host to grow nor are they killed.

Researchers have found it difficult to get cultured human cells to undergo transformation and to form tumors when introduced into experimental animals. Using the sponge technique, the Los Alamos investigators have been able for the first time to get newly transformed human fibroblasts to form tumors in mice, he says.

"If the host kills the cells, you can infer that you have an immunologic response," Dr. Kraemer notes. "But we are interested in the progression of cancer cells in various stages of transformation," with immune responses kept to a minimum. It is necessary, however, to take special precautions to protect the immunodeficient mice from exposure to infectious organisms.

Additional reading:

1. Goolsby, C. L., Cooper, J. L., Bartholdi, M. F., Cram, L. S., and Kraemer, P. M., Early events in the SV_{40} transformation of human cells. *Cancer Research*, in press.
2. Akporiaye, E. T., Kudalore, M., Stevenson, A. P., Kraemer, P. M., and Stewart, C. C., Isolation and reactivity of host effectors associated with the manifestation of concomitant tumor immunity. *Cancer Research* 48: 1153–1158, 1988.
3. Akporiaye, E. T., Saunders, G. C., and Kraemer, P. M., A gelatin sponge model for studying tumor growth: Quantitation of tumor cells and leukocytes in the CHO tumor. *Experientia* 43:589–721, 1987.
4. Kraemer, P. M., Travis, G. L., Saunders, G. C., Ray, F. A., Stevenson, A. P., Bame, K., and Cram, L. S., Tumorigenicity assays in nude mice: Analysis of the implanted gelatin sponge method. In *Immune-Deficient Animals*, (Sordat, B., ed.). Fourth International Workshop on Immune-Deficient Animals in Experimental Research, Chexbres 1982 (Basel: Karger, 1984), pp. 214–219.
5. Kraemer, P. M., Travis, G. L., Ray, F. A., and Cram, L. S., Spontaneous neoplastic evolution of Chinese hamster cells in culture: Multistep progression of phenotype. *Cancer Research* 43:4822–4827, 1983.
6. Wells, R. S., Campbell, E. W., Swartzendruber, D. E., Holland, L. M., and Kraemer, P. M., Role of anchorage in the expression of tumorigenicity of untransformed mouse cell lines. *Journal of the National Cancer Institute* 69:415–423, 1982.

The research described in this article was supported by the U.S. Department of Energy, the Biomedical Research Technology Program of the NIH Division of Research Resources, and the Arizona Disease Control Research Commission.

For Additional Information:

To locate information or professional contacts on this effort, contact:

Research Resources Information Center
1601 Research Boulevard
Rockville, MD 20850
(301) 984-2870

Refer to Volume XIII, No. 3/TN

U.S. Navy Technology Application

Microwave Apparatus for Heating Contained Liquid

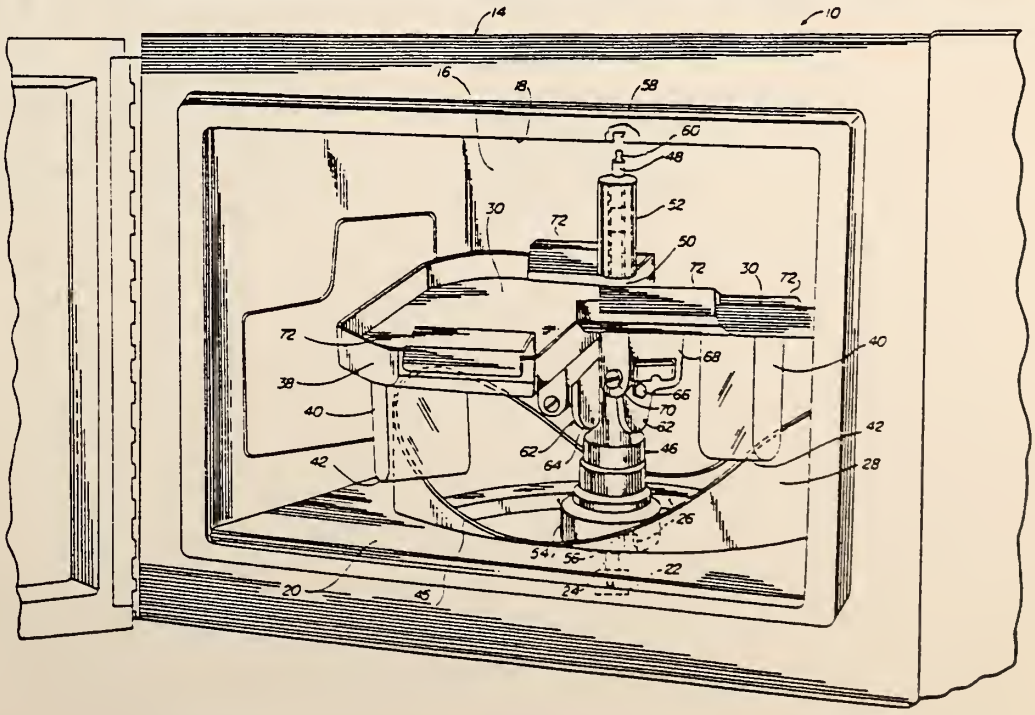
An apparatus is provided to thaw frozen blood components which are contained in a bag. The heating apparatus includes an off-the-shelf microwave oven with added hardware to hold up to four units of frozen packed red blood cells. These units are rotated around the oven and mixed during heating. Use of microwave heating eliminates the need to thaw blood components in a warm water bath, thereby eliminating a source of contamination.

STAGE OF DEVELOPMENT

The apparatus is fully developed and tested. Medical evaluation and ruggedness testing have not yet been performed.

APPLICATIONS

This apparatus has an immediate application in the Navy's Blood Program, and also will be useful in private Blood Banks.



PATENT STATUS

United States Patent Number: 4,742,202 May 3, 1988.

PUBLICATIONS

None relating to this specific patent. See "Temperature Monitoring System for Microwave Thawing of Blood" by Campbell et al in Navy Technical Disclosure Bulletin, Vol 12, No 2, Dec 1986, and Patent No 4,503,307 for related inventions.

Additional Information

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Nancy Campbell, Code 441, Naval Ocean Systems Center, San Diego, CA 92152-5000. Telephone: (619) 553-3645.

NAVY
Domestic Technology Transfer Fact Sheet

Naval Dental Research Institute Studies Relationship of Treponema denticola and Periodontal Disease

Researchers at the Naval Dental Research Institute have recently discovered that Treponema denticola, an oral spirochete, was present at significantly elevated levels in subgingival plaque samples collected from patients with severe periodontitis relative to healthy controls and moderate disease subjects. The ratio of Treponema denticola content per milligram of plaque in the deep pocket groups to that of the other two groups was about 2:1 for two separate human populations. The Treponema denticola content of dental plaque was quantitatively estimated for samples taken from periodontitis patients as well as healthy subjects. The two populations studied included military volunteers and civilians at a university dental clinic. The plaque samples from each population were grouped at the collection site according to pocket depth measurements. An enzyme-linked immunosorbent assay procedure was developed using a monoclonal antibody specific for a Treponema denticola serovar. This study represents the first quantitative evidence of a positive relationship between a specific spirochete species and severe periodontitis.

For Additional Information:

Backup material on this effort is available from:

Navy Domestic Technology Fact Sheet Reader Reply Service
Code E211
Naval Surface Weapons Center
Dahlgren, VA 22448-5000
(703) 663-8921

Refer to 140204/TN

HHS Fact Sheet

U.S. Department of Health & Human Services

Applications of DNA Probes for the Diagnosis of Human Infectious Diseases: An Overview

An overview has been made of DNA/RNA probe (DNA probe) applications for the diagnosis of human bacterial, viral, and parasitic diseases. The purpose of the study was to provide public health officials, health-care professionals, and other interested personnel with a working knowledge of the clinical utility of these diagnostic tests. Although this technology is not new, the medical applications are relatively recent, and the scientific literature has grown extensively in the past few years. Consequently, health-care professionals, although needing to understand this technology, are not always able to keep up with the volume of scientific literature. This study is intended to assist health-care personnel in understanding and planning for anticipated developments in this rapidly growing field.

The study examined the clinical utility of DNA/RNA probes for in vitro diagnosis of human bacterial, viral, and parasitic diseases. Basic methods and concepts of nucleic acid hybridization (DNA/RNA probe) technology were briefly reviewed, and the current and future clinical ramifications of this technology were discussed.

DNA/RNA probe technology offers the potential of replacing a variety of current microbiological techniques with a single set of DNA/RNA probe techniques. This is expected to simplify existing microbial identification techniques and result in greater efficiency and less operating cost for clinical laboratories. It is anticipated that clinical laboratories will use DNA/RNA probe technology routinely when nonradioactive probes marketed as kits become more widely available. This technology is expected to have an important impact on health-care services in the United States.

FOR ADDITIONAL INFORMATION: A copy of the report is available from NTIS, Springfield, VA 22161; (703)487-4600.
NTIS order number: PB89-120497/NAC
Price Code: A03

NIH
Research & Technology
U.S. Department of Health and Human Services Public Health Service National Institutes of Health

Low Field Magnetic Resonance Imaging Using a 0.15 Telsa Resistive Magnet

A combination of improved radiofrequency coils and computer software produces clear magnetic resonance images of the pelvis at lower field strength than has previously been possible to use effectively, according to investigators at the University of Florida College of Medicine.

Magnetic resonance imaging (MRI) is a noninvasive diagnostic technique that originally was based on the resonance of the body's most ubiquitous atom, hydrogen, but that more recently has been further developed to utilize the resonances of other atoms as well. The magnetic resonance images of normal and diseased organs are as good and often better than those that can be obtained by computed tomography (CT), and the procedure does not involve the use of x rays.

Countries with limited health care funds might benefit from the development of low-field-strength MRI machines, says Dr. Derek J. Hamlin, clinical associate professor of radiology at the University of Florida in Gainesville. The magnetic field strength is measured in units called "tesla." A few years ago a 1.5-tesla imager was mounted on a trailer, Dr. Hamlin recalls. In contrast, "General Electric now has a 0.5-tesla machine in a van; it is a matter of using smaller magnets to best advantage," he explains.

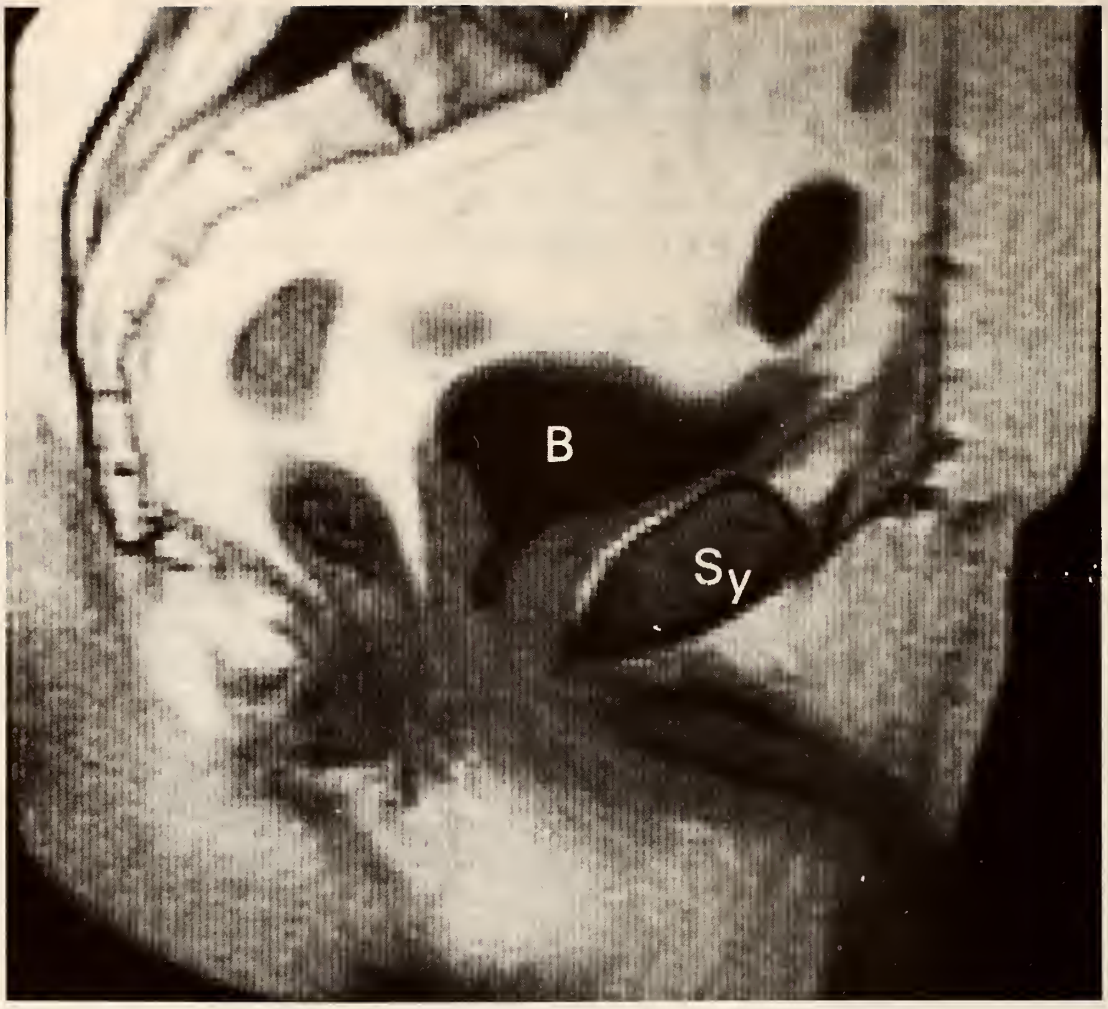
A magnetic resonance image is recorded with the patient placed in a stationary magnetic field that causes the hydrogen nuclei in the body to align with the field. Subsequently, a probe coil emits pulses of radiofrequency magnetic fields that force the hydrogen nuclei out of alignment; when the pulses are stopped they realign themselves—"relax"—in the field and simultaneously induce radiofrequency signals in the probe coil. The signals, which vary slightly in different environments inside the body and depend on the relaxation times, are recorded and translated into images by a computer.

Dr. Hamlin and his colleagues used a 0.15-tesla resistive magnet that is both smaller and less expensive than the large and powerful electromagnets most centers use. "Low field strengths can nevertheless be diagnostic," he says. By adapting the hardware Hamlin, this design produced a significant improvement in resolution of details.

The Florida investigators studied 70 patients with pelvic lesions; 27 of them had gynecologic malignancies and 12 had benign gynecologic lesions. The rest of the patients had cancer of the bladder, prostate, rectum, or of the bones in the pelvic area.

Images were recorded as contiguous or closely spaced slices of 10 millimeters each. The researchers used a new type of body coil for the study. It is formed like a half-saddle, and the patient is positioned on top of the coil to minimize motion artifacts. According to Dr. Hamlin, this design produced a significant improvement in resolution of details.

The investigators found that the relaxation times, T1 and T2, were characteristic and predictive of different abnormalities.



Magnetic resonance image (side view) of a 57-year-old male patient following a transurethral resection of the prostate gland. The image, obtained with a 0.15-tesla scanner, shows the gray area under the bladder (B) where the prostate gland was situated.

They were able to identify and stage the extent of cervical carcinoma, and in two cases they could establish by MRI that a tumor had not spread to the pelvic wall as suggested by a computed tomography scan. "MRI is good for characterizing lesions," Dr. Hamlin says. "For example, in endometriosis one finds chocolate cysts, so-called because they contain blood that gives them a dark color. With MRI not only can we tell if there is blood in the cyst, but also whether it is recent or old blood." MRI has another distinct advantage over CT, according to Dr. Hamlin. By varying the angle of the radiofrequency pulse, MRI can provide not only transaxial views—directed perpendicularly to the long axis of the body—but can produce images along two other planes, the sagittal and the coronal, as well.

Dr. Hamlin is interested in staging tumors with MRI. "Some of the work I have done has shown that MRI is superb at staging tumors," he says. "I'm interested in seeing if it offers significantly more accuracy than CT." MRI has its limitations, however. The method failed to demonstrate any abnormality in several patients with bladder carcinoma, especially in patients with bladder walls thickened by infection or radiation therapy.

Although the studies with low-field-strength magnets look promising, Dr. Hamlin believes that from a technical point of view the 1.5-tesla instruments are the most desirable. "You get very clear, very beautiful images with the 1.5-tesla," he says. He sees an ever greater role for MRI as a diagnostic tool, if the instruments are affordable. "The price has to be low enough so it can be used for many procedures, and it must provide very useful information. The medical community is very cautious about procuring overly expensive items," Dr. Hamlin notes.

For Additional Information:

To locate information or professional contacts on this effort, contact:

Research Resources Information Center
1601 Research Boulevard
Rockville, MD 20850
(301) 984-2870

Refer to Volume XII, No. 12/TN

Natural Resources Technology & Engineering

0504 Downhole Seismic Source Performs Well in Experiments

Sandia National Laboratory

Downhole Seismic Source Performs Well in Experiments

An experimental seismic generator that could help energy companies find and evaluate oil and gas deposits more efficiently has performed extremely well in recent field tests, according to Sandia National Laboratories researchers.

Sandia has completed development efforts on a full-scale prototype of the downhole seismic source and is in the process of transferring the technology to industry for commercialization. The source generates strong seismic signals from deep drillholes for the purpose of creating underground images.

Field tests conducted in June at Amoco Production Company's Mounds test site near Tulsa, Okla., verified that the source operating inside a drillhole can generate seismic signals that can travel at least 1,700 ft through the underground and be detected and recorded. Its Sandia developers believe the tool can operate in drillholes up to 2 miles deep and generate useful signals that extend for several miles.

Field tests establish range

The 1,700-ft range was verified during hole-to-hole experiments at the Amoco site, where the source and geophone receivers were operated several hundred feet down separate drillholes. Data from such tests are used to produce images of underground sections, indicating geologic details in a predetermined plane.

Such images are currently produced using acoustic transmitters and geophone receivers at ground level. In hole-to-hole measurements, the seismic source is placed down one drillhole, and receivers are placed down one or more other drillholes. The resulting data can be analyzed and used to produce images that indicate geological details in three dimensions.

Sandia's Harry Hardee says the main advantage of hole-to-hole measurements over surface-based seismic techniques is that seismic signals that are generated and received downhole give an improved "picture" of the underground.

"By placing the seismic source and the receivers downhole, we can significantly reduce the distance seismic signals must travel and thereby get a better defini-

tion of the underground," he explains. "Also, seismic signals generated from deep within a drillhole and traveling to receivers within another hole remain much stronger than seismic signals that travel through weathered, near-surface regions."

The new downhole seismic source generates a strong, horizontal pattern of shear waves that the receivers can detect. Shear waves, or S waves, are particularly useful for detecting underground fluids. Cables leading from the receivers relay the signals to recorders at the surface.

Signals weaken in near-surface regions

Field tests of hole-to-hole shear wave attenuation, done at Sandia in June, confirmed that shear waves in the 70 to 150 Hz range are attenuated (weakened) considerably as they go through near-surface regions less than 300 ft deep. These tests produced numerical values for the attenuation of shear waves in shallow regions as a function of wave frequencies.

The hole-to-hole tests at the Amoco site were successful in drillholes ranging to 500 ft deep at the maximum possible source-to-receiver spacing of 1,700 ft. Hardee believes these distances are sufficient to represent typical oil field applications.

Downhole seismic tools being developed at Sandia have other potential applications. Hardee foresees civil engineering and mining applications to detect underground cavities and fluid-filled regions.

FOR ADDITIONAL INFORMATION

Public Information Division,
Code 3161,
Department of Energy,
Sandia National Laboratories,
Albuquerque, NM 87185-5800
(505) 844-4207
Refer to announcement 23, No. 6

Physical Sciences

0505 Novel Semiconductor Laser Provides Unique Advantages

0506 NRL Scientists Develop New Soft X-Ray Lasers

0507 DIPPR Database Expanded to 1,023 Pure Compounds

0508 Mercury Ion Laser-Cooled to Limit

Testing & Instrumentation

0509 Improving Lead-In-Fuel Analyses is Aim of Materials

0510 Test Can Help Ensure Industrial Chemical Purity

0511 Semiempirical Model Would Control Czochralski Process—Simple equations relate processing conditions.

0512 Photopolymerization of Levitated Droplets—Microspheres of controllable composition are made rapidly. (Licensing Opportunity)

Other Items of Interest

0438 Measurement or State-of-the-Art Integrated Circuits

0450 Evolution of Cenospheres—Microscopy reveals changes in structure during combustion.

Sandia National Laboratory

Novel Semiconductor Laser Provides Unique Advantages

Scientists at Sandia National Laboratories have demonstrated a new kind of semiconductor laser that has important fundamental advantages over conventional types. It has possible applications ranging from optical computing to improved optical telecommunications.

The scientists have, for the first time, demonstrated high-efficiency, continuous-wave, room-temperature operation in epitaxial surface-emitting laser structures.

The microscopic laser - it is shaped like a hockey puck but is less than one-tenth the thickness of a human hair on a side - is a custom-tailored single crystal with mirrors and lasing medium precisely grown layer by layer in the laboratory. It is grown by molecular beam epitaxy.

Not only does the laser emit light through the top surface, it operates continuously at room temperature, has a high-quality optical beam with small divergence, and high output power efficiency under optical pumping.

This geometry confers enormous advantages over conventional semiconductor lasers, which emit horizontally from a cleaved wafer edge and typically have diffuse, highly divergent beams. These advantages combined with its surface-emitting character provide a fundamentally new laser with a host of unique properties.

A surface-emitting laser allows use of large areas of a semiconductor chip and, because the laser material need not have an exposed edge, much better integration of optical and electrical components in a single planar system. Surface-emitting lasers have been made before, but they have not exhibited the high beam quality or high power efficiency of the Sandia laser. Further advantages of using a layered active region are under investigation. These advantages include periodic laser gain, a concept recently proposed by scientists at the University of California at Santa Barbara and the University of New Mexico, Albuquerque.

"We have a surface-emitting laser that is very efficient and operates continuously at room temperature," says Paul L. Gourley, the Sandia physicist who heads the research effort. "This at least matches previous semiconductor lasers. But it has the advantage that the light comes out the surface and it has a very well defined, circular beam."

Conventional semiconductor lasers have a widely divergent (up to 35-degree-angle), fuzzy, highly noncircular beam, which means much of the light is wasted when they are coupled, say, to a circular opening of an optical fiber. The Sandia laser diverges as little as 2.5 degrees and the beam cross section is circular, allowing for very efficient coupling to an optical fiber.

Gourley, supervisor of Sandia's Semiconductor Physics Division, says the laser is also highly stable ("it has operated continuously for days") and it has much better temperature characteristics than conventional semiconductor lasers - the laser threshold can be very insensitive to temperature variations.

Tests show the laser has an input-to-output power efficiency of about 30 percent. Once pumped to lasing, the differential power efficiency is 80 percent. The laser's continuous output is up to 60 milliwatts with no observable degradation after many hours operation. The lasing occurs on a single longitudinal mode, another advantage over conventional semiconductor lasers which tend to have many modes, or frequencies, operating at once.

Paul Peercy, manager of Sandia's Compound Semiconductor and Device Research Department, calls the laser a "significant advance" that has "fundamental advantages" over existing semiconductor lasers.

The laser is, so far, pumped optically (by a visible-light laser) rather than electrically. But Gourley is confident electrical pumping will be achieved. "It's just a matter of time."

The Sandia epitaxial surface-remitting laser is made by using molecular beam epitaxy to grow a single crystal with well-ordered atomic multilayers comprising both upper and lower mirrors and the active multiple quantum well lasing region. "We can make layered crystals in which quantum and optical size effects are brought together," says Gourley, who has spearheaded this research in collaboration with Sandians Thomas Brennan, Ralph Dawson, Burrell Hammons, Robert Biefeld, Thomas Zipperian, Timothy Drummond (now at the University of Michigan), and Anthony McDonald.

The mirror reflectors are composed of precisely controlled alternating layers of aluminum arsenide and aluminum gallium

arsenide. The active region is composed of gallium arsenide and aluminum gallium arsenide. The thickness of each of the reflective layers is precisely tailored to be one-quarter the wavelength of the desired frequency of light. The thickness of the active region is an integral number of half-wavelengths of the light. Under these conditions there is resonant transmission of light.

The surface-emitting laser is one of a whole family of new optical devices being developed at Sandia using the same crystal growth technology. The other devices include optical switches, optical modulators, and optical detectors. All make use of similar single-crystal semiconductor mirrors. All can be monolithically integrated with other device structures.

"Using a single epitaxial structure, we have demonstrated the four elements needed for an optical computer," says Gourley. "We have a source of light, the laser; a switch of light; a modulator of light: and a detector. You can imagine an integrated system that employes these in an optical computer." The surface-emitting characterics and high efficiencies might make it possible to assemble millions of such lasers.to carry out rapid, massively parrallel chip-to-chip optical communication within future optical computer, he says.

Optical computing and optical communications appear to be the most prominent applications for the new technology, but there are very likely to be others as well.

The laser's output light is in the near-infrared, at a wavelength of about 850 nanometers (8500 angstroms). Gourley says it can be tuned over a range of hundreds of angstroms.

Very recently Gourley and his colleagues have extended the technology to the 1-micron (1000-nanometer) spectral region by making a high-efficiency, continuous-wave, near-room-temperature, surface-emitting laser from strained layers of other materials, specifically indium gallium arsenide. "This is the first time anyone has made a surface-emitting laser using strained layers, much less one that is continuous wave," says Gourley. Strained-layer-superlattice technology, pioneered at Sandia, allows materials of different lattice structure to be combined in thinly grown layers. "So this means that the technology is not limited to lattice-matched materials," points out Gourley. This enables much greater flexibility in choice of materials and properties for cutsom-tailored devices.

FOR ADDITIONAL INFORMATION: Public Information Division, Code 3161, Department of Energy, Sandia National Laboratories, Albuquerque, NM 87185-5800: (505)844-4207. Refer to announcement 24, No. 1.

NAVY
Domestic Technology Transfer Fact Sheet

NRL Scientists Develop New Soft X-Ray Lasers

Researchers at the Naval Research Laboratory (NRL), Washington, D.C., have demonstrated lasing at soft X-ray wavelengths in copper and germanium plasmas that were heated by a high-power infrared laser.

Although the present output power of these NRL lasers is rather modest (a few kilowatts in a pulse about one-billionth of a second long), further improvements will take the power up to megawatts, where many military and civilian applications requiring short laser wavelengths can be realized. These applications include X-ray lithography and microscopy, X-ray holography, and flash radiography.

Since early 1970, researchers have sought to produce extreme ultraviolet and soft X-ray lasers. However, it was not until 1984 that a group at the Lawrence Livermore National Laboratory, Livermore, California, conclusively demonstrated that they had produced such a laser in a high-temperature plasma created from the ultrathin foil of selenium that was heated by a high-power glass laser.

The NRL researchers say that they built upon this early similar laser gain using a much simpler target (a thick slab instead of an ultrathin foil), and a much lower-power glass laser heating source (approximately one-tenth the power level). In addition, strong lasing lines were seen that had been predicted but not previously observed.

The team states that to generate the X-ray lasing light, NRL's Pharos III neodymium glass laser was operated at an infrared wavelength, a pulse energy up to 500 joules, and a pulse duration of two-billionths of a second. This laser had been developed by NRL for use in laser fusion and nuclear weapons effects research. For the X-ray laser experiments, the infrared laser light was focused to a line about two centimeters long and 200 microns wide. The emitted X-ray lasing lines were recorded on a small grazing-incidence spectrograph which had been developed by NRL's Space Science Division for their rocket spectroscopy program.

For Additional Information:

Backup material on this effort is available from:

Navy Domestic Technology Fact Sheet Reader Reply Service
Code E211
Naval Surface Weapons Center
Dahlgren, VA 22448-5000
(703) 663-8921

Refer to 140107/TN

NIST Technology Update

National Institute of Standards & Technology
(Formerly the National Bureau of Standards)
U.S. Department of Commerce, Gaithersburg, MD 20899

DIPPR Database Expanded to 1,023 Pure Compounds

More than 250 pure chemical compounds have been added to a computerized data base on the thermodynamic and physical properties of chemicals. The database, DIPPR (Design Institute for Physical Property Data), Data Compilation on Pure Compound Properties, 1989, now contains information of 39 properties for 1,023 pure chemical compounds of high industrial priority. The database provides chemical engineers, manufacturers, and scientists in industry, government, and universities with quick access to important information on the behavior of substances and their reactions at various temperatures. The chemicals in the database were selected by the industry members of the American Institute of Chemical Engineer's (AIChE) DIPPR group, and are considered to be the most imortant ones to industry.

FOR ADDITIONAL INFORMATION: For information on fees and license agreements for NIST Standard Reference Database 11, DIPPR, Data Compilation of Pure Compounds, 1989, contact the Office of Standard Reference Data, NIST, A323 Physics Bldg., Gaithersburg, Md. 20899; (301)975-2208.

NIST Technology Update

National Institute of Standards & Technology
(Formerly the National Bureau of Standards)
U.S. Department of Commerce, Gaithersburg, MD 20899

Mercury Ion Laser-Cooled to Limit

Scientists at NIST's Time and Frequency Division, Boulder, Colo., have succeeded for the first time in laser-cooling a bound atomic ion to its fundamental limit. "We pushed the atom into the ground state of its confining well. That's the end of cooling for a bound particle," says project leader David J. Wineland. Their finding is important for spectroscopy, a study of the nature of matter through various radiations it emits. One result may be the development of a highly sensitive spectrum analyzer. A report on their work appears in the Jan. 23, 1989, issue of Physical Review Letters. They shined laser light on a mercury ion sideband frequency generated by the Doppler effect associated with thermal motion. The result was to reduce the ion's kinetic energy, limit its movement, and sharpen its spectral features. The ion was confined in a radio frequency "trap."

FOR ADDITIONAL INFORMATION: To discuss these efforts further, contact Dr. David J. Wineland, National Institute of Standards & Technology, 325 Broadway, Division 576, Boulder, CO 80303; (303)497-5286. Media Contact: Fred McGehan (Boulder), (303)497-3246.

NIST Technology Update

National Institute of Standards & Technology
(Formerly the National Bureau of Standards)
U.S. Department of Commerce, Gaithersburg, MD 20899

Improving Lead-In-Fuel Analyses is Aim of Materials

Elevated lead levels in the environment could be caused by a number of sources, but one of the chief culprits may still be the alkyl lead used as an additive in gasoline, according to some reports. Because the Environmental Protection Agency regulates lead content in fuel emissions as part of air quality standards, the petroleum industry needs accurate measurement techniques to ensure compliance with federal emission limits. To aid industry in calibrating the instruments that analyze fuel samples and to help confirm the accuracy of measurement techniques, NIST has developed four different standard reference materials (SRMs). Individually, the SRMs consist of gasoline-like fuel in vials, with each SRM representing a different certified lead level (.0297, .0506, .0733, and 2.045 grams per gallon of lead, respectively). By analyzing the SRM fuel the same way as a fuel sample, a chemist can gauge how well analytical instruments and techniques are working at four different lead levels.

FOR ADDITIONAL INFORMATION: The new SRMs, numbered 2712 through 2715, are available for $110 each from the Office of Standard Reference Materials, NIST, B311 Chemistry Bldg., Gaithersburg, MD. 20899; telephone: 301/975-6776.

NIST Technology Update

National Institute of Standards & Technology
(Formerly the National Bureau of Standards)
U.S. Department of Commerce, Gaithersburg, MD 20899

Test Can Help Ensure Industrial Chemical Purity

In numerous high-technology industrial processes, chemicals called reagents are used as integral parts of the processes. It is crucial that these chemicals be extremely pure. The electronics industry, for example, uses reagents in themanufacture of semiconductor devices and needs to ensure that these chemicals do not contaminate devices with impurities. Even trace impurity amounts - parts per million or lower - must be measured and controlled. To address this need, researchers in the NIST Center for Analytical Chemistry have created a technique using inductively coupled plasma/mass spectrometry (ICP-MS), which allows improved purity tests of reagents to be made. Analysis of high-purity reagents for contaminants is particularly demanding, requiring rigorous control over the laboratory environment and procedures. The ICP-MS instrument is well-suited to these demands and offers advantages such as high sensitivity (parts per billion or lower), broad coverage of elements, and ease in sample introduction. So far, NIST researchers have used ICP-MS to analyze hydrochloric, nitric, hydrofluoric, sulfuric, and perchloric acids, as well as high-purity water, with a 10-fold or more increase in sensitivity over other methods.

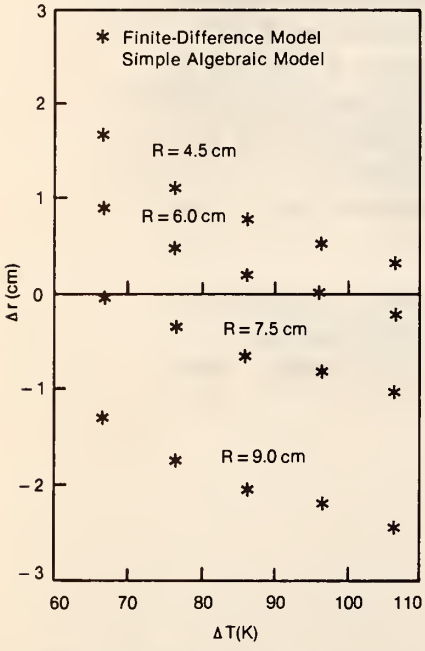
FOR ADDITIONAL INFORMATION: To discuss these efforts further, contact Dr. John Moody, Chemistry Building, Room A353, National Institute of Standards & Technology, Gaithersburg, MD 20899; (301)975-4134. Media Contact: John Henkel, (301)975-2762.

NASA Tech Brief
National Aeronautics and Space Administration
NASA's Jet Propulsion Laboratory, Pasadena, California

Semiempirical Model Would Control Czochralski Process

Simple equations relate processing conditions.

A semiempirical mathematical model has been proposed for the control of the growth of single crystals of silicon by the Czochralski process. The model expresses the dependence of the pulling rate and the shape of the liquid/solid interface upon the important process variables; namely, the radius of the growing crystal, the temperature of the crucible, the level of the melt, and the height of the exposed portion of the wall of the crucible. It is necessary to control the shape of the interface in a manner consistent with the other variables, to maintain a radially uniform concentration of dopant, and to reduce thermally induced stresses in the vicinity of the interface.



A **Simple Algebraic Model** and a computerized finite-difference model were used to predict the convexity (negative Δr) or concavity (positive Δr) of a crystal-growth interface at various crystal radii and temperature differences.

The Czochralski process is dominated by the conductive transfer of heat inside the melt and crystal; by the radiative transfer of heat to and from the surfaces of the melt, crucible, and crystal; and, to a lesser extent, by convection in the melt. The thermal environment near the interface changes during growth because the level of the melt falls, exposing more of the wall. Thus, to grow a crystal of the required diameter while maintaining the required shape of the interface, it is necessary to adjust both the heating power (to affect the temperature of the crucible) and the pulling speed according to a mathematical model of the process to compensate for the changing conditions.

The equations are derived from basic considerations of the transfer of heat across all the affected surfaces. In this analysis, convection is ignored, and the melt is assumed to have a uniform temperature. The equations are

$$v = (A - B_1 h_c \Delta T)/R - B_2 \Delta T/h$$
$$h = h_o - (\rho_c/\rho_m)(R/R_c)^2 L$$
$$h_c = h_o - h + h_{co}$$
$$\Delta r = (a_1 - a_2 \Delta T)R - (b_1 - b_2 \Delta T)R^2$$

where v = the pulling speed; ΔT = the difference between the temperatures of the melt and the crystal; R = the radius of the crystal; h and h_o represent the present and initial heights of the surface of the melt, respectively; h_c and h_{co} represent the present and initial heights of the exposed portion of the wall of the crucible, respectively; L = the total distance through which the crystal has been pulled; R_c = the radius of the crucible; ρ_c and ρ_m represent the densities of the crystal and melt, respectively; Δr = the difference in height between the center and the edge of the interface; and a_1, A_1, a_2, A_2, b_1, B_1, b_2, and B_2 are constant parameters that are found by fitting the equations to measurements from the crystal-growing apparatus to be controlled or to the predictions of a more-complete thermal analysis.

The equations were compared with the results of such an analysis that was performed with a conduction-dominated finite-element model. Because the equations fit the predictions so well, they might be used to simulate complete growth cycles without requiring the excessive computer time that would be consumed by rigorous finite-element modeling.

This work was done by M. P. Dudukovic, P. A. Ramachandran, and R. K. Srivastava of Washington University for **NASA's Jet Propulsion Laboratory**. *NPO-17271/TN*

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C 2457(f)], to Washington University. Inquiries concerning licenses for its commercial development should be addressed to

Washington University
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Campus Box 1054
One Brookings Drive
St. Louis, MO 63130

Jet Propulsion Lab.
NASA Resident Office
Technology Utilization Officer: Gordon S. Chapman
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FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*
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NASA Tech Brief
National Aeronautics and Space Administration
NASA's Jet Propulsion Laboratory, Pasadena, California

Licensing Opportunity

Photopolymerization of Levitated Droplets

Microspheres of controllable composition are made rapidly.

An experimental containerless process combines two established techniques to make a variety of polymeric microspheres. In a single step, electrostatically-levitated monomer droplets are polymerized by ultraviolet light. The process is faster than the multiple-step emulsion polymerization process now used to make microspheres.

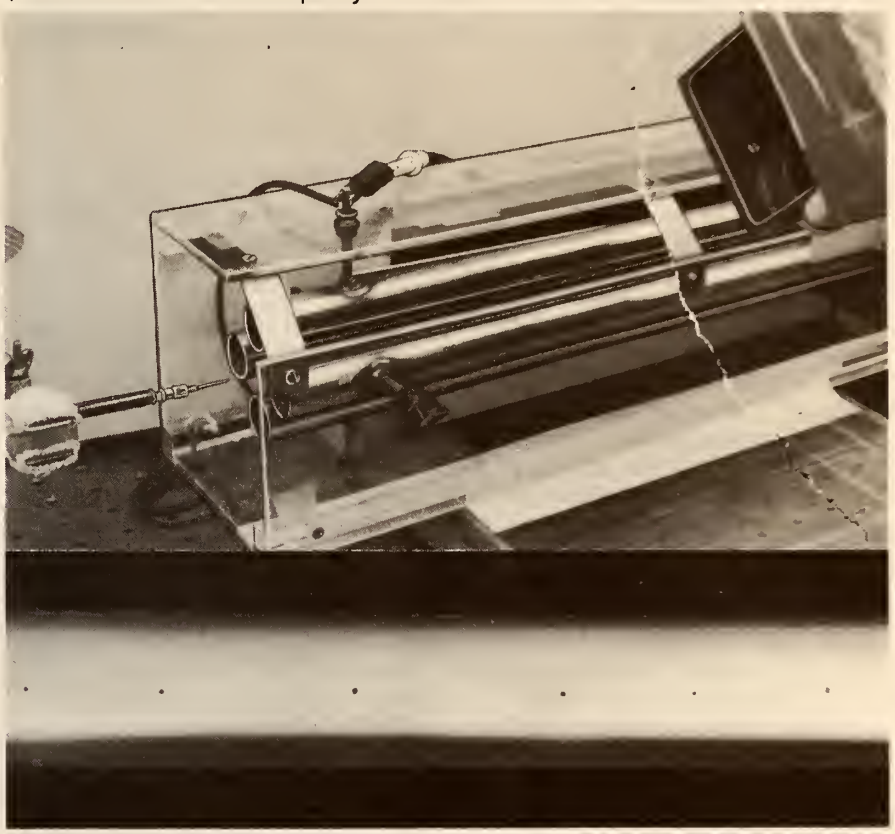
Electrically-charged liquid droplets are prepared by a commercial or laboratory droplet generator. The droplets can include a monomer or a mixture of monomers. Optional ingredients include additives to speed polymerization, magnetic particles, fluorescent dyes, proteins, catalysts, and blowing agents to induce porosity.

The droplets are suspended in a cylindrical quadrupole electrostatic levitator (see figure). An alternating electrostatic field produces a dynamic potential well along the axis. Many dense droplets up to a few microns in diameter can be suspended along the axis without clumping. The ac voltage required for levitation depends on the droplet charge-to-mass ratio and is typically about 3 kV.

The suspended droplets are irradiated with ultraviolet light, which causes them to polymerize into solid beads. The polymerization time depends on the ingredients and the ultraviolet intensity; in preliminary experiments, it took a few minutes. The microspheres can be made unusually pure, not only because the process is containerless but also because no solvents or other reactants are necessary for polymerization.

By the choice of ingredients and particle size, it is expected that the process will enable the tailoring of microspheres for medical, scientific, and industrial applications. These may include the following:

- The magnetic separation of cancer cells;
- The labeling and visualization of cellular structures by optical or electron microscopy;
- Porous beads serving as large-surface-area catalysts or catalyst supports;
- Affinity chromatography requiring uniform microspheres;
- The calibration of sieves and particle-measuring instruments;
- Magnetic coatings for data storage; and
- Diagnosis, therapy, or drug targeting by means of timed-release beads and/or beads guided into position with magnets.



In the **Quadrupole Electrostatic Levitator** (above), droplets to be polymerized are suspended along the axis (below).

This work was done by Alan Rembaum, Won-Kyu Rhim, Michael T. Hyson, and Manchium Chang of Caltech for **NASA's Jet Propulsion Laboratory**.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

Edward Ansell,
Director of Patents and Licensing
Mail Stop 301-6
California Institute of Technology
1207 East California Boulevard
Pasadena, CA 91125

Refer to NPO-16551/TN

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Transportation & Components

0513 Navy Investigates Helicopter Static Electricity Problem

0514 Terrain-Following/Terrain-Avoidance System for Helicopters—Numerical simulations will be followed by piloted simulations. (Licensing Opportunity)

NAVY
Domestic Technology Transfer Fact Sheet

Navy Investigates Helicopter Static Electricity Problem

Funded by Office of Naval Research, Washington, D.C., and the Marine Corps, investigators are trying to learn why hovering helicopters accumulate static electricity. Once sources are determined, mitigation methods can be created.

Although no fatalities have been directly attributed to the static electricity, the massive electrical charge can cause serious burns, and the environment is unsafe for sick or injured personnel who are being transported.

Scientists at New Mexico Institute of Mining and Technology, Socorro, New Mexico, have theorized that the hot exhaust gases of the helicopter engine may be a major contributor of electrification. Also, more electricity seems to be produced when the helicopter is hovering over dusty surfaces. Even without dust, a CH-53E Super Stallion has shown more than 30,000 volts.

One possible control method is by attaching an electrostatic shield over the engine's exhaust, coupled with applying controlled voltages to electrodes immersed in the ionized exhaust gases. Further tests and measurements are planned.

For Additional Information:

Backup material on this effort is available from:

Navy Domestic Technology Fact Sheet Reader Reply Service
Code E211
Naval Surface Weapons Center
Dahlgren, VA 22448-5000
(703) 663-8921

Refer to 140101/TN

NASA Tech Brief
National Aeronautics and Space Administration

Licensing Opportunity

Terrain-Following/Terrain-Avoidance System for Helicopters

Numerical simulations will be followed by piloted simulations.

A report describes the early stages of development of a control system that will enable a helicopter to follow automatically the contours of the terrain below it and avoid collisions with the terrain. The report focuses on the optimization of the algorithm for the generation of the flightpath with respect to several variables, the development of a controller to position the helicopter precisely along the terrain-following/terrain-avoidance (TF/TA) flightpath, and integration of the flightpath-trajectory software with flightpath-control software.

The trajectory-generating algorithm first generates the horizontal components of the trajectory between specified way points, then generates the vertical components to maintain the required clearances above the ground. The algorithm evaluates prospective flightpaths and ranks them according to a cost function that penalizes altitude and lateral deviation from the reference flightpath. A parameter in the cost function can be varied to obtain more terrain following at the expense of terrain avoidance, or vice versa.

A mathematical model of an 18,000-lb (8,200-kg) helicopter, a digital terrain-data base, trajectory-generation software, and the flightpath controller were combined to produce an off-line computer simulation of the complete terrain-following/terrain-avoidance system. This model will be used to optimize the system for an anticipated piloted simulation in the Vertical Motion Simulator at Ames Research Center.

Since the guidance software requires a finite time (about 5 seconds) to compute the trajectory for flight over a new patch of ground that lies ahead, the aircraft states at the start of a patch have to be predicted on the basis of current states and the trajectory for the current patch. Each time the trajectory for a new patch is computed, the solution is passed to the flightpath controller, which then provides control inputs to the helicopter model.

Preliminary results of the numerical simulation show that the trajectory-generating algorithm seeks valleys while maintaining the nominal reference course and that the flightpath controller provides helicopter-control inputs to maintain the desired trajectory. These results indicate that the guidance and flightpath-control software are functioning adequately. Nevertheless, detailed analysis of the integrated system will be required before the piloted simulation can be carried out.

This work was done by Dan W. Dorr of **Ames Research Center.** *Further information may be found in NASA TM-88323 "Rotary-Wing Aircraft Terrain-Following/Terrain-Avoidance System Development." [N87-13122/NSP],* Price Code A04

Copies may be purchased from the National Technical Information Service, Springfield, Virginia 22161, Telephone No. (703) 487-4650.

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Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Ames Research Center
Refer to ARC-11731/TN

Ames Research Ctr.
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Patent Counsel:
Darrell G. Brekke
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FOR ADDITIONAL INFORMATION: *Contact: Director, Technology Transfer Division, P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 Ext. 241*
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